University of Pennsylvania: The Wharton School
OPIM 210 - Management Information Systems
Instructor Il-Horn Hann - Fall 1998

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University of Pennsylvania, Wharton School
Department of Operations and Information Management

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OPIM 210 - Management Information Systems
Fall 1998
MW 12-1:30, Room TBA

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Course Overview

The shift in the economy from the industrial era to the information age has profound implications for the management of the modern enterprise. Firms are experimenting with new types of products, production processes, organizational structures, and competitive strategies that have been enabled by the use of information technology (IT). In this "information economy", there is tremendous demand for managers that can combine technical skills with business insight to create value for their organizations using IT, whether they work in the information systems function or elsewhere.

This course provides a broad-based introduction to the management of information systems focusing on three interrelated themes: technology, organization, and strategy. The goal of this course is to equip students with the knowledge and tools they need to analyze, design, build, and implement information systems taking into account both technological and business factors.

There are no prerequisites except for a general interest in both business and technology issues.

Course Format

Classes will include a mixture of case discussions, lectures, computer demonstrations and possibly guest speakers. The course is highly interactive in nature, so students are expected to come to class prepared to discuss the readings.

The majority of the material will be conveyed in lecture or in readings in the bulk pack from Wharton reprographics. In addition, there will be a textbook which is useful as a reference material as well as being the primary source of readings for much of the technical material. Both the bulk pack and the textbook are *required*. Occasionally, I will also distribute copies of my lecture notes and other handouts to the class (these will be billed to your bursar account under course handout option "B" from Wharton reprographics).

To encourage students to do the reading, there will be a short question or questions for many of the sections in which the reading is particularly critical. Students will be required to send in 8 of these short questions (1/2 to 1 page essays) during the semester out of a possible 12 opportunities. In

management gibberish, buzzwords ("we are going to proactively reengineer our key business processes to focus on our core competencies and exploit scale economies in pursuit of competitive advantage") and platitudes ("people are our most important asset") since the use of such phrases suggests to intelligent people that you really have no idea what you are trying to say. If you want to use a particular management phrase such as "competitive advantage", define your terms precisely and apply them consistently and thoughtfully.

Class Schedule

NOTE: THE READINGS LISTED FOR EACH SESSION AND THE SHORT QUESTIONS ARE FOR THAT DAY (e.g., Brynjolfsson should be read before the first class). The only exception is written question 1 which is due by Sep 14, along with written question 2.

Sep 9 W Introductions, Course Overview and the Business Value of IT

Read: Brynjolfsson, Technology's True Payoff
Read: Course Syllabus
Read: Lucas, Ch. 3 (optional)

Written Question #1 (due by Sep 14): Use your favorite web browser to go to the OPIM 210 web site (to be announced in class). Get your password and fill out the student information sheet.

Sep 14 M Introduction to Strategy

Read: Porter, Competitive Strategy: The core concepts, p 1-27
Read: Porter and Millar, How Information Gives You Competitive Advantage
Look at: Problem Set #1 (Due Sep 23 at the beginning of class)

Written Question #2 (due by Sep 14): What is competitive advantage? What is sustainable competitive advantage? To what extent are advantages created by information systems sustainable?

Sep 16 W Strategy (continued) and Strategic IS

Read: InformationWeek, Sabre Gives Edge to American Airlines
Read: InformationWeek. AHSC On-line System Ships Supplies ASAP.
Read: Lucas, Ch. 5 (skim)
Read: Guidelines for Case Analysis

Written Question #3: Draw a diagram of the five competitive forces and the value chain for the personal computer industry. How might information technology be used to improve the competitive position of a computer company (say, Dell or Micron)?

Sep 21 M Modern Information Systems Strategy: Capital One

Read: Clemons and Thatcher, Capital One...
Think about: Questions for Case Discussion (p. 11)

Written Question #4: When they first started, all Nigel and Rich had was an idea. How were they able to overcome the disadvantage they had, given that other credit card companies already have customers, operations and a tremendous amount of customer information?

Sep 23 W Classic IS Strategy: Baxter Healthcare ASAP Express

Read: Baxter Healthcare: ASAP Express (Case)
Think about: Questions for Case Discussion (p. 12)

PROBLEM SET #1 Due at the Beginning of Class (see p. 12 for questions)

Sep 28 M Introduction to Computer Hardware

Read: Lucas, Chapters 7, 8, 13 (skim)
Read: How Computers Work - on reserve (optional)

Sep 30 W Hardware (continued): Current Issues

Read: Site: http://www.intel.com/

Oct 5 M Introduction to Software

Read: Lucas, Chapter 9
Look at: Problem Set #2 (due by Oct 21, see p. 13)

PRELIMINARY PROJECT PROPOSAL due at the beginning of class
Please e-mail to: hann36@wharton.upenn.edu

Oct 7 W Databases and database design

Read: Lucas, Chapter 10

Oct 12 M Communications and Networks I

Read: Lucas, Chapter 11
Read: How the Internet Works - on reserve (optional)

Oct 14 W Communications and Networks II

Read: Lucas, Chapter 12
Read: Forbes, "Cybercops"

Oct 19 M Fall Break

Oct 21 W IT and Organizations

Read: Malone and Rockart, Computers, Networks and the Corporation (skim)
Read: Drucker, The Coming of the New Organization
Read: Hitt and Brynjolfsson, IT and Internal Organization (excerpt)
Read: Lucas, Ch. 4 (optional)
Look at: Problem Set #3 (due by Nov 2, for questions p. 16)

Written Question #5: How does information technology relate to the emergence of the "New Organization"?

PROBLEM SET #2 Due at the beginning of class

Oct 26 M Technology and Organization in Manufacturing

Read: Bylinski, A Breakthrough in Automating the Assembly Line
Read: The Expense Tracking System at Tiger Creek (Case)
Think about: Questions for Case Discussion (p. 15)

Written Question #6: Was the expense tracking system at Tiger Creek Mill a success? What factors were important in determining the outcome of the system implementation?

Oct 28 W Decision Support Systems/Executive Information Systems

Read: Phillips 66 Company: Controlling a Company Through Crisis (Case)
Read: Lucas, Ch. 21, p. 553 - 565 (only)
Think about: Questions for Case Discussion (p. 16)

PROBLEM SET #3 Due at the beginning of class (see questions on p. 16)

Nov 2 M Expert Systems and Artificial Intelligence
Read: Lucas, Ch. 22
Read: The Brooklyn DA's Office: Client Contact Systems (Case)
Think about: Questions for Case Discussion (p. 17)

Written Question #7: Evaluate the choice of "buy and bust" narcotics cases for the prototype system.

FINAL GROUP PROJECT PROPOSAL due at the beginning of class

Please e-mail as a word attachment to: hann36@wharton.upenn.edu

Nov 4 W Economic Analysis of Information Systems

Read: Kaplan, Must CIM Be Justified by Faith Alone
Read: Clemons, Evaluation of Strategic Investments in Information Technology

Written Question #8: What factors make information systems more difficult to evaluate than most capital investments?

Nov 4 W Optional Evening Session for Midterm Review
Look at: Sample Midterm Exam
Room: TBA, 6-8PM

Nov 9 M Midterm Examination (in class)
Covers material through Nov 2 (Brooklyn DA)

Prepare: One sheet of notes 8 1/2" x 11" both sides for use during exam

Nov 11 W Introduction to Systems Analysis and Software Engineering

Read: Lucas, Ch. 15-16
Read: Lucas, Ch. 17 (optional)

Nov 16 M The Pitfalls of Software Development

Read: Microsoft Corporation: Office Business Unit (Case)
Think about: Questions for Case Discussion (p. 18)
Look at: Problem Set #4 (due by Nov 25, see p. 21)

Written Question #9: What do you think were the key management decisions that led to the difficulties of the OPUS project? To what extent do you think Microsoft will be able to avoid these problems in the future?

Nov 18 W Reengineering in Theory

Read: Hammer, Reengineering Work: Don't Automate, Obliterate
Read: Davenport and Short, The New Industrial Engineering: Information Technology and Business Process Redesign

Written Question #10: The popular press has suggested that most reengineering projects "fail". While it is not clear that this is true, it suggests that reengineering has tended to be very difficult. What do you think reengineering is so difficult to perform successfully?

Nov 23 M Information Systems Outsourcing

Read: Drucker, Sell the Mailroom
Read: CSC/General Dynamics Case - Handed out in class
Think about: Questions for Case Discussion (p. 19)

Written Question #11: Depending on which side of the case you will be analyzing (CSC or General Dynamics), write a brief summary of what you would want to get out of an outsourcing arrangement and how you would want it structured.

Nov 25 W Reengineering in Practice

Read: Reengineering the Sales Function: Reengineering Internal Operations
Think about: Questions for Problem Set #4 (see p. 21)

PROBLEM SET #4 Due at the beginning of class (see questions p. 21)

Nov 30 M Outsourcing an IT Intensive Service

Read: Delaware Valley Financial Services: Managing the Customers Perception of Strategic Vulnerability
Think about: Questions for Case Discussion (p. 20)
Look at: Problem Set #5 (due by Dec 9, see p. 22)

Written Question #12: DVFS appears to be able to offer lower cost and better service, even to large clients. What are the sources of the advantages that DVFS can offer?

Dec 2 W Reserved for Student Presentations (actual class may be rescheduled to evening)

Dec 7 M Reserved for Student Presentations (actual class may be rescheduled to evening)

Dec 9 W Course Summary

PROBLEM SET #5 Due at the beginning of class
WRITTEN PROJECT REPORT DUE

TBD Evening review session for the final exam
Read: Sample final exam (handed out in class)
Read: Procter and Gamble... (case for final exam)

Questions for Case Discussion

Capital One

1. What behaviors by incumbent firms created the opportunity for Signet Bank (and later Capital One) to make major strategic gains in the credit card market?

2. How were information systems linked to the strategy at Capital One/Signet?

3. Does Capital One have a sustainable competitive advantage in credit cards? How do you know?

4. What markets appear to be vulnerable to the strategies pioneered by Capital One. In other words, where should Nigel and Rich be looking for their next kill?

Questions for Case Discussion and Written Analysis

Baxter Healthcare Corporation: ASAP Express

Problem Set #1 (due September 23 at the beginning of class): Answer the following questions about the Baxter Case:

1. (50%) Were the earlier versions of the Baxter ASAP system a source of competitive advantage? Was it a source of sustainable competitive advantage? Analyze the factors that determined whether it provided competitive advantage and whether the advantage was sustainable. (Note: Earlier versions refers to the first version of ASAP up until ASAP express. If at some point the system changed to a source of competitive advantage or from being a source of competitive advantage, note the point at which it changed and why)

2. (25%) Why would Baxter want to create a "level playing field" with the ASAP express system? Is this a good idea?

3. (25%) What competitive threats does Baxter face as they move forward with ASAP express? What can they do to address them?

Questions for Discussion (not to be handed in)

1. What is the structure of the hospital supplies industry? What are the important characteristics of buyers and suppliers from a competitive standpoint?

2. What does the value chain of a hospital look like? Where are potential opportunities for a hospital supply company to improve the economics of hospital operations?

3. How important is price competition in the hospital industry? What types of market imperfections exist?

4. What resources does Baxter Healthcare have that distinguishes it from the competition? How does ASAP Express fit in?

5. Has Baxter managed the development and implementation of ASAP effectively? What have they done right and wrong?

Problem Set #2 - Technology

Due October 21 at the beginning of class

1. (40%) Recently companies have been incorporating 128-bit video cards into desktop and laptop PCs for high performance multimedia applications. These cards contain a microprocessor which handles the operation of the card, memory for storing screen images and a digital to analog converter for converting data stored in memory into a video signal for a monitor. They are designed to be installed in PC-compatible computers using a Pentium processor and operate over the PCI bus. Please answer the following questions (Note: 1) some of these are very short answer and others require some analysis, 2) It is not necessary and may even be counterproductive to do outside research on the architecture of video cards -- this question is answerable just from what is given and what we have discussed in class).

a. What does "128-bit" mean in this context? What does "performance" mean in this context?
b. Clearly, manufacturers are trying to convince you that "more bits are better" in promoting these cards. Can a 128-bit card underperform a 32-bit card? Explain.
c. What is the difference between a CISC and a RISC microprocessor? Which type of microprocessor is most likely to be incorporated into this video card? Why?
d. If the buyer of this card wishes to work with still images that are composed of 600 vertical x 800 horizontal pixels in 24-bit color (24-bits per pixel) how much memory needs to be on the card? What type of memory device would you expect to be used for handling this size image if maximum performance is desired (limit yourself to devices discussed in class)?
e. Suppose now that you instead want to display video at 30 frames per second at the resolution and color depth described in part d (assume no compression). Clearly this is more data than can be economically stored on the card. How fast does the bus have to be to accommodate this level of data flow? In a modern PC, which bus is this card likely to be connected to?
f. Suppose you are going to receive your video signal from your local area network. To make the image manageable, you have cut it back to 8 bit color and slowed the frame rate down to 10 frames/second, although you want to retain the full screen (600x800) size. Assume that you have exclusive use of a 10-base-T connection, the packet size is 1000 bytes of actual data plus another 100 bytes of address and packet information, what is the minimum amount this signal needs to be compressed in order to be effectively transmitted to you?
g. Would the amount of compression required increase or decrease if the video was sent to your local area network over the internet for instantaneous playback? Why?
h. Would the answer to part g be any different if you could delay playback and store some of the image locally (you do not have to do the actual calculation)? What type of device would you use for local storage?

2. JAVA is a much hyped computing innovation that has attracted a lot of attention in the last year. As part of the propoganda blitz, Sun released a whitepaper in which they made the following claim:

(the full paper is at http://www.sun.com/javacomputing/whpaper/ch1_overview.html)

"There is much discontent in today's enterprise computing, stemming from several causes:

It is too complex
The constant administration and upgrading of desktops is too expensive
It is not secure enough
It is not reliable enough
Incompatible desktops prevent universal access to applications
Applications take too long to develop and deploy"

and comment later that "JAVA is uniquely position to address these problems".

Using the world wide web, locate as much information as you need to answer the following questions (you should be able to answer these questions in a page or two). A good place to start is the whitepaper referenced above and that may be all that you need.

a) (10%) Explain to an non-technical executive what JAVA is and how it works? How does it differ from other types of programming environments?

b) (20%) Evaluate the third claim on the list above ("it is not secure enough"), again using language a non-technical executive can understand. To what extent is this true? To what extent is JAVA uniquely positioned to address this problem?

c) (15%) If JAVA is widely adopted, who is likely to gain and who is likely to lose? Explain.

3. (15%) Intel in their public advertisements states that an MMX enhanced processor can run applications as much as 40% faster than an equivalent non-MMX processor (e.g. the regular Pentium). For more information on Intel's processors see: http://www.intel.com/

a) What accounts for the speed advantage that the MMX processor provides?

b) What types of applications are likely to benefit the most from MMX capabilities? Why?

c) What is necessary to realize the maximum (40%) speed enhancement?

Questions for Case Discussion

The Expense Tracking System at Tiger Creek

Questions for Discussion (not to be handed in)

1. How has the system changed the nature of the job for workers? For managers? Is the ETS an example of centralization or decentralization of decision rights?

2. Why do you think the rate of cost savings has declined? What could be done to get the cost savings back on track?

3. Part of the problems that Tiger Creek is experiencing may be due to technology implementation. Do you think that the technology was implemented effectively? What else would you have done to ensure success?

Questions for Case Discussion and Written Analysis

Phillips 66 Company: Controlling a Company through Crisis

Problem Set #3 (Due October 28 at the beginning of class):

1. (20%) In the abstract, what are the tradeoffs between centralizing and decentralized decision making? How can IT affect the optimal location of decision rights?

2. (40%) Analyze the how the organizational architecture (decision rights, incentives and monitoring systems) was changed at Phillips. Be sure to examine the changes for both senior management and line/field managers. How did information systems relate to these changes in organizational architecture?

3. (20%) What was the impact of these changes within the organization (please be specific)? Do you think the IS investments needed to support these changes were justified?

4. (20%) What could threaten the ongoing success of the new organization at Phillips (again, please be specific)?

Questions for discussion (not to be handed in):

1. How was EIS implemented? In particular, what roles did Bob Wallace and Gene Batchelder play?
2. How was decision making conducted before EIS? How was it changed by the implementation of EIS?
3. What were the tangible and intangible benefits of EIS? What were the costs?
4. Are the benefits of the ETS likely to extend to other divisions? What would be the value of using ETS throughout the company?
5. Some managers are concerned that they no longer have sufficient control over the business. Does it make sense to recentralize control of pricing and other operational decisions now that ETS is in place?

Questions for Case Discussion

The Brooklyn DA: Client Contact Systems

1. What factors lead to the decision to implement video-linkages and CACE?
2. What are the benefits of the CACE system? What are the costs?
3. The project was originally started on "buy-and-bust" narcotics cases. Why was this application chosen? Is this a reasonable strategy for a pilot project?
4. Which stakeholders stand to gain from CACE? Which stakeholders are likely to be worse off? How should the distribution of benefits affect how the system is implemented?
5. Think about the questions raised in the "implications and limitations" section at the end of the case.

Questions for Case Discussion

Microsoft Corpcration: Office Business Unit

1. What was impetus for the OPUS project?

2. Why did the OPUS project take so long? What factors do you believe led to these problems?

3. What are the advantages and disadvantages of using experienced developers for project management? What are the advantages and disadvantages of using domain experts for project management?

4. Examine the three options that Microsof: has put forward. Analyze the proposals in terms of the Clemons' risk framework. How should Microsoft proceed?

Questions for Case Discussion

CSC/General Dynamics: Outsourcing

1. What was the motivation to outsource at GD? Were they justified?

2. Evaluate CSC as a vendor - were they an appropriate choice?

3. What benefits does each party get from the outsourcing agreement?

4. What factors about the two companies are important in determining the ultimate success of the outsourcing arrangement?

5. What provisions are important to be included in the contract? Why?

Questions for Case Discussion

Delaware Valley Financial Services (DVFS)

1. What advantages might a firm like DVFS offer to a large, established player in the annuities business? What advantages might DVFS offer to a new entrant in the annuities business?

2. What risks might a customer experience when they outsource annuity operations to DVFS? Think of specific examples of how they might appear in the case. (Surely, DVFS does not know about Poaching, Shirking and Opportunistic Renegotiation, but the opportunities for each are clearly present in the case)

3. Why is it important for Lois Haber to minimize the perception that clients are at risk? What steps has she taken to reduce or eliminate the perception of risk?

4. As a manager considering outsourcing to DVFS, what steps would you take to minimize the risks?

Questions for Case Discussion and Written Analysis

Reengineering the Sales Function: Reengineering Internal Operations
SNM Pharmaceuticals

Problem Set #4 (Due at the beginning of class on Nov 25)

Your client, the board of SNM pharmaceuticals, is puzzled about how to improve organizational performance. They have tried investing in forecasting systems to predict the variability of demand so that they can better meet customer orders, but these attempts were largely unsuccessful. They suspect that the problems have something to do with incentives and information flow, but are not sure. Your job, if you choose to accept it, is to analyze their current processes, information flows and incentives and develop a recommendation on how they should proceed. Specifically, you are to answer the following questions:

1. (20%) What are the problems that SNM faces that are stated in the case? What other problems do they have that you can infer from the information given?

2. (20%) Draw a *data flow* diagram for SNM and the relevant external parties. Draw a high level diagram of the material flows (you are free to use whatever notation you prefer for the "high level" diagram).

3. (30%) For each of the major entities that are part of or related to SNM describe how their actions, incentives, work processes or other characteristics contribute to the problems that you have identified.

4. (30%) Identify a set of changes you would make to SNM. This should include both changes in the way they conduct their work as well as information systems that support the new design. For the changes you suggest, be sure to analyze or understand how they might interact (positively or negatively) with existing or proposed organizational practices.

We will discuss these questions in class on the day the assignment is due.

Problem Set #5

Due December 9 at the beginning of class

1. (30%) Brooklyn DA. Analyze the value of the investment in the video system. If this system were to be paid for in present value terms by reduction in police overtime, using the numbers in the case and the following assumptions, compute how much overtime savings is necessary over five years (in terms of the percentage of total overtime). Assumptions: 5% discount rate, investments are made at the beginning of the year zero and operating costs (other than initial) are paid at the end of each year, starting with year 1. The system has a lifetime of 5 years after which the equipment could be auctioned for 15% of the original investment. Please state explicitly any further assumptions you need to make and the source of any numbers you use. For this evaluation, you can assume that wages and caseload are stable over the five year period.

2. (50%) You are a consultant hired by Bob Pliskin, CFO of Executive Financial of New York (EFNY), a small mutual fund company. EFNY manages five portfolios of equities, bonds and derivative securities that for a large number of individual investors. One of the Bob's major responsibilities is the nighly portfolio valuations. This involves keeping track of share ownership of each security, when purchases and sales were made, accounting for all purchases and sales made by the portfolio managers during the day, and matching security holdings to several different outside services that provide pricing data. In addition to producing the valuation, holdings information and performance data needs to be provided to the portfolio managers as well as a variety of periodic reports for tax and regulatory purposes.

EFNY currently has a system that provides all these functions called MTM (for mark-to-market). The system was written in COBOL in 1973, has about 200,000 lines of code, and runs on a Burroughs mainframe. There is currently a staff of six programmers maintaining the system and another two that maintain the hardware. The programmers spend about half of their time making changes to the system to keep up with current regulatory changes and another half of their time altering the system to handle new types of securities or expand the capacity of the system to accommodate increased security holdings. Bob is beginning to be concerned that the system is becoming too complex to maintain, that it does not provide the right information to the portfolio managers, and that the increasing pace of regulation in mutual funds will require more and more IS staff that need to be trained on the system. Furthermore, developing workarounds and managing the maintenance of the system is beginning to occupy more and more of Bob's time (one of Bob's friends, CEO Adrienne Hauk recently commented, "Pliskin, I heard you were becoming a systems expert..."). In addition, he is becoming increasingly concerned that the systems group is so overwhelmed with keeping the system running that there is no time to make enhancements that will help his firm stay competitive.

Recognizing that if he doesn't do something soon, the situation could become explosive, Bob has asked you to evaluate several options he is considering and propose other avenues that he could pursue in greater depth. Bob has already decided that the Burroughs has to go, but the replacement system and software are still undecided. The options that are now under discussion are:

Option A is to use in-house staff to "downsize" the application to a client server environment, preserving as much of the original code as possible using MicroFocus COBOL, which is a client-server (PC-based) version of COBOL that is quite similar to the dialect they currently are using.

Option B is to hire a new development team to rewrite the program to duplicate the original functionality, but reorganize the code and port it to a more modern language. Another group at EFNY recently hired a new team of programmers to develop new applications in C++ and Bob thinks he could get management approval for a similar type of project. The platform has not been decided, although the previous group did their work on high-end PCs.

Option C is to purchase this package and modify it slightly to meet the needs of EFNY. Bob has already identified one option: a company called 59th Street Software offers a package that automates all the mutual fund accounting tasks including valuation, security inventory tracking and portfolio reporting. They advertise that it "helps navigate the minefield of government regulation in the mutual funds industry" and is currently in use at several companies that are similar to EFNY. The system is multi-platform and can run under several different mainframe operating systems, as well as Windows NT and several different variants of UNIX.

Please answer the following questions:

a) Using the Clemons' risk evaluation framework, evaluate the risks in the three options described above as well as a default project of maintaining the status quo. (No need for a large amount of detail; an ordering and brief explanation will suffice).

b) Based on this analysis and your own analysis, which of these options appears to be the most promising to pursue in greater depth. (In addition to risks, you may want to consider costs, fit with the organization,...). For this option, what additional factors should Bob be examining before choosing to go forward.

c) Suggest and analyze at least one other option that Bob should consider examining. How does this option compare to the other options already on the table?

3. (20%) The Economist in their recent survey of the consulting industry argued that most successful firms will combine strategy consulting with capabilities in information systems. As a potential client, what are the advantages of having the same firm do your strategy and your systems design/development? What are the disadvantages?

October 10, 1994

Issue 496, page 34

Section: InformationWeek 500

Column: Trends

Technology's True Payoff -- An MIT survey finds that business tends to overlook intangibles when evaluating information technology

By Erik Brynjolfsson

A few years ago, the business press was filled with stories about the so-called "productivity paradox" of computers: The billions of dollars poured into computers didn't seem to boost worker output. While these stories were based on research indicating that computers hadn't pulled their weight in the 1970s and early 1980s, the press reaction was out of proportion to the more carefully worded academic papers on the subject.

The pendulum has now swung with full force in the opposite direction. Last year, after Lorin Hitt and I published a study that found a correlation between computer investment and significantly higher output in a sample of 300 large companies, the same business publication that had screamed "Productivity Paradox" on its cover only a few years before ran another cover story on the "Technology Payoff." Dozens of similar stories followed.

While it appears that there has been some turnaround in productivity, both headlines overstate reality and give short shrift to the limitations of the underlying academic studies on which they were based. As more research is done, we are gradually developing a clearer picture of the relationship between information technology (IT) and productivity. However, as someone whose research focuses on this area, I feel compelled to issue a warning: Productivity measurement isn't physics. Our tools are still blunt, and our conclusions not as definitive as we would like. Although it is understandable that managers want clear-cut answers, far more work will have to be done before the last word is written on IT productivity.

In any event, an excessive focus on aggregate productivity statistics can distract us from the realities of using IT to create customer value.

Perhaps the most important reality is that despite what the statistics say about the "average" return on IT investment, each manager must decide which projects are worthwhile. There is no bank where companies can deposit IT investments and withdraw an "average" return. On the contrary, at the height of the disillusionment with computer productivity, the financial institutions I visited were quietly reaping returns in the hundred of millions of dollars on their IT investments. More recently, I watched a large insurance carrier write off a $100 million failed investment in a

billing system. Productivity does not automatically follow IT dollars--it takes a lot of hard work.

Another key reality is that even when high productivity is achieved, it does not automatically translate into competitive advantage. In fact, a single-minded focus on productivity can be counterproductive. Competitive advantage comes from delivering what customers value and from doing so in a way that cannot be easily copied.

Because productivity is typically construed to involve a narrow focus on reducing costs and increasing throughput, it diverts attention from areas like customer service, quality, and timeliness. These areas are not as easy to quantify, but they are often places where IT can have the biggest impact. Customer values have shifted from mass consumption toward subtler, quality-of-life issues. Although conventional measures of productivity are better at accounting for physical input and output, that's no reason to rely solely on these factors.

Achilles' Heel

The typical approach of basing an investment decision on whether a new technology increases productivity may sound sensible, but it misses an important point: Technology is only a tool, and it's one that rivals can acquire. If a company tries to hone its competitive edge on technology alone, it will soon find itself imitated. Technology must be aligned with the core competencies of the company to deliver true value.

For some corporations, cost leadership remains a distinct advantage. For them, productivity is the essential metric. But for others, customer intimacy or product excellence sets them apart, and their emphasis should be on different metrics. This is not to say that productivity can be ignored by any company. Costs must at least be competitive before other factors can be exploited. Evaluating the productivity effects of information technology (IT) is an important first step toward achieving advantage, but it is only a first step.

While my past work at MIT focused on the conventional approach to productivity measurement, my colleagues and I have begun to take a broader view of the potential benefits of IT. Working with InformationWeek, we studied input from 285 companies on the IW 500 listing. Some of the preliminary results confirm the importance of looking beyond cost savings to identify the contributions of computers. In fact, the No. 1 benefit that managers of IW 500 companies say they expect from their IT investments is improved customer service. Lowering costs is the next most important benefit, say the managers. But they also stress timeliness of interactions with customers, higher product and service quality, support for reengineering efforts, and better flexibility.

Cutting Costs Is Not Key

The emphasis on customer service is apparent in virtually every industry surveyed. Cutting costs is stressed by companies in the energy, mining, and commodities businesses, where cost competition is rampant. Cutting costs is also a priority for insurance and health-care companies. Quality is stressed by pharmaceuticals companies and, to some extent, the banking industry--in

these fields, small mistakes can cost millions of dollars.

Saving time is the priority of the computer hardware and service industries, where product cycles are measured in months. Improving timeliness also ranks highest in general manufacturing. In fact, despite all the evidence of these companies' successes in cutting costs over the past decade, manufacturing puts less emphasis on cutting costs than any other industry. The survey suggests that for many manufacturers, low prices are a necessity, but competitive advantage comes from faster delivery, higher quality, and improved customer service.

The architecture of information systems must be adapted to support these new goals. This makes the original selling point for client-server systems--that they are cheaper than mainframes--increasingly irrelevant. While there is evidence that client-server can cut costs, we found that the IW 500 companies moving most aggressively to client-server architectures were less interested in cost savings than the other corporations in our sample. Instead, client-server-oriented corporations expect the greater benefits from their investments to come from improved timeliness and better support of organizational reengineering efforts (see charts, p. 35).

Of course, these benefits are difficult to quantify, so many companies' official justification for moving to client-server is cost savings. One manager in a diversified financial company thought the main benefits of the new system would be to allow top management to more quickly identify customer-service problems and develop scenarios for product introductions. But because his management demanded that "hard" benefits be identified, he confessed that he justified the system mainly on the basis of eliminating several dozen clerks and systems personnel. He told me a post-audit was unlikely once the system was in place, and he suspected he would never be forced to make the staffing cuts.

According to the IW 500 survey, there is one IS strategy that closely focuses on cost-cutting: outsourcing. While this could be construed as evidence that outsourcing saves money, more complex factors are at work. Because lower costs are relatively easy to measure, this is one of the few IS goals that can be delegated to an outsider. When the IS group is called on to support more ambiguous goals, outsourcing is more likely to lead to conflict.

The difficulty of measuring benefits such as improved customer service also makes it difficult to justify IT spending and to intelligently set budgets. Therefore, it is encouraging that only a minority of companies in our survey (25%) have resorted to using the old rule of thumb of setting IS budgets based on a fixed proportion of total revenues.

Using traditional capital budgeting approaches is more difficult when the costs and benefits of IS are intangible. But that does not mean companies should abandon them altogether. On the contrary, extra caution should be applied to avoid the common trap of assuming that if something can't be measured well, it should be ignored. This strategy is tantamount to valuing corporate intangibles at zero, which is no less arbitrary than making an educated guess.

As businesses move to an information era that emphasizes competition on the basis of customer service, quality, and speed of delivery, new measures will have to be developed to augment our Industrial Age concept of productivity.

Fortunately, some of the hidden benefits and costs of new IT systems can be quantified without too much difficulty. For instance, managers at many manufacturing plants find they can attach dollar values to the inventory savings, reduced space requirements, and decrease in rework enabled by MRP (manufacturing resource planning) II systems. These benefits often amount to more than the direct labor and energy savings gained from the system. Similarly, the life- cycle costs of maintenance, training, and support, when properly measured, typically dwarf the up-front costs of new computer systems.

Another danger of focusing narrowly on maximizing traditional productivity measures: It can inhibit creative thinking about how technology affects other business processes. While computer systems must be aligned with business goals, this does not necessarily mean implementing a one-sided adaptation of the technology. In some cases, the best strategy is to modify business processes and goals to better exploit the technology. Not only can this lead to new ways of providing customer value, but when ntechnology is used to leverage special competencies of a business, it also becomes much more difficult for competitors to duplicate the approach.

It's easy to draw the wrong conclusions from the reports that IT spending has been linked to improved productivity. Not only is IT spending alone unlikely to achieve the reported productivity gains, but given the way most corporations measure it, productivity by itself may also be too constricting a goal. Designing and implementing accurate measures and linking IT to real business needs is not easy. What's more, these moves may not always succeed. But a strategy of blindly investing in IT and expecting productivity to automatically rise is sure to fail.

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Technology's True Payoff -- An MIT survey finds that business tends to overlook intangibles when evaluating information technology

By Erik Brynjolfsson

A few years ago, the business press was filled with stories about the so-called "productivity paradox" of computers: The billions of dollars poured into computers didn't seem to boost worker output. While these stories were based on research indicating that computers hadn't pulled their weight in the 1970s and early 1980s, the press reaction was out of proportion to the more carefully worded academic papers on the subject.

The pendulum has now swung with full force in the opposite direction. Last year, after Lorin Hitt and I published a study that found a correlation between computer investment and significantly higher output in a sample of 300 large companies, the same business publication that had screamed "Productivity Paradox" on its cover only a few years before ran another cover story on the "Technology Payoff." Dozens of similar stories followed.

While it appears that there has been some turnaround in productivity, both headlines overstate reality and give short shrift to the limitations of the underlying academic studies on which they were based. As more research is done, we are gradually developing a clearer picture of the relationship between information technology (IT) and productivity. However, as someone whose research focuses on this area, I feel compelled to issue a warning: Productivity measurement isn't physics. Our tools are still blunt, and our conclusions not as definitive as we would like. Although it is understandable that managers want clear-cut answers, far more work will have to be done before the last word is written on IT productivity.

In any event, an excessive focus on aggregate productivity statistics can distract us from the realities of using IT to create customer value.

Perhaps the most important reality is that despite what the statistics say about the "average" return on IT investment, each manager must decide which projects are worthwhile. There is no bank where companies can deposit IT investments and withdraw an "average" return. On the contrary, at the height of the disillusionment with computer productivity, the financial institutions I visited were quietly reaping returns in the hundred of millions of dollars on their IT investments. More recently, I watched a large insurance carrier write off a $100 million failed investment in a

billing system. Productivity does not automatically follow IT dollars--it takes a lot of hard work.

Another key reality is that even when high productivity is achieved, it does not automatically translate into competitive advantage. In fact, a single-minded focus on productivity can be counterproductive. Competitive advantage comes from delivering what customers value and from doing so in a way that cannot be easily copied.

Because productivity is typically construed to involve a narrow focus on reducing costs and increasing throughput, it diverts attention from areas like customer service, quality, and timeliness. These areas are not as easy to quantify, but they are often places where IT can have the biggest impact. Customer values have shifted from mass consumption toward subtler, quality-of-life issues. Although conventional measures of productivity are better at accounting for physical input and output, that's no reason to rely solely on these factors.

Achilles' Heel

The typical approach of basing an investment decision on whether a new technology increases productivity may sound sensible, but it misses an important point: Technology is only a tool, and it's one that rivals can acquire. If a company tries to hone its competitive edge on technology alone, it will soon find itself imitated. Technology must be aligned with the core competencies of the company to deliver true value.

For some corporations, cost leadership remains a distinct advantage. For them, productivity is the essential metric. But for others, customer intimacy or product excellence sets them apart, and their emphasis should be on different metrics. This is not to say that productivity can be ignored by any company. Costs must at least be competitive before other factors can be exploited. Evaluating the productivity effects of information technology (IT) is an important first step toward achieving advantage, but it is only a first step.

While my past work at MIT focused on the conventional approach to productivity measurement, my colleagues and I have begun to take a broader view of the potential benefits of IT. Working with InformationWeek, we studied input from 285 companies on the IW 500 listing. Some of the preliminary results confirm the importance of looking beyond cost savings to identify the contributions of computers. In fact, the No. 1 benefit that managers of IW 500 companies say they expect from their IT investments is improved customer service. Lowering costs is the next most important benefit, say the managers. But they also stress timeliness of interactions with customers, higher product and service quality, support for reengineering efforts, and better flexibility.

Cutting Costs Is Not Key

The emphasis on customer service is apparent in virtually every industry surveyed. Cutting costs is stressed by companies in the energy, mining, and commodities businesses, where cost competition is rampant. Cutting costs is also a priority for insurance and health-care companies. Quality is stressed by pharmaceuticals companies and, to some extent, the banking industry--in

these fields, small mistakes can cost millions of dollars.

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The architecture of information systems must be adapted to support these new goals. This makes the original selling point for client-server systems--that they are cheaper than mainframes--increasingly irrelevant. While there is evidence that client-server can cut costs, we found that the IW 500 companies moving most aggressively to client-server architectures were less interested in cost savings than the other corporations in our sample. Instead, client-server-oriented corporations expect the greater benefits from their investments to come from improved timeliness and better support of organizational reengineering efforts (see charts, p. 35).

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Another danger of focusing narrowly on maximizing traditional productivity measures: It can inhibit creative thinking about how technology affects other business processes. While computer systems must be aligned with business goals, this does not necessarily mean implementing a one-sided adaptation of the technology. In some cases, the best strategy is to modify business processes and goals to better exploit the technology. Not only can this lead to new ways of providing customer value, but when ntechnology is used to leverage special competencies of a business, it also becomes much more difficult for competitors to duplicate the approach.

It's easy to draw the wrong conclusions from the reports that IT spending has been linked to improved productivity. Not only is IT spending alone unlikely to achieve the reported productivity gains, but given the way most corporations measure it, productivity by itself may also be too constricting a goal. Designing and implementing accurate measures and linking IT to real business needs is not easy. What's more, these moves may not always succeed. But a strategy of blindly investing in IT and expecting productivity to automatically rise is sure to fail.

The information revolution is tranforming the nature of competition

How information gives you competitive advantage

#85415

Michael E. Porter and Victor E. Millar

It is hard to overestimate the strategic significance of the new information technology. This technology is transforming the nature of products, processes, companies, industries, and even competition itself. Until recently, most managers treated information technology as a support service and delegated it to EDP departments Now, however, every company must understand the broad effects and implications of the new technology and how it can create substantial and sustainable competitive advantages.

The authors of this article provide a useful framework for analyzing the strategic significance of the new information technology. They show how and why the technology is changing the way companies operate internally as well as altering the relationships among companies and their suppliers, customers, and rivals. They go on to identify three specific ways that the technology affects competition: it alters industry structures, it supports cost and differentiation strategies, and it spawns entirely new businesses. They outline five steps to help managers assess the impact of the information revolution on their own companies.

Mr. Porter is professor of business administration at the Harvard Business School. He is the author of the new best-seller Competitive Advantage *(Free Press, 1985) and* Competitive Strategy *(Free Press, 1980), and he recently served on the Presidential Commission on Industrial Competitiveness.*

Mr. Millar is the managing partner for practice of Arthur Andersen & Co. and is responsible for the professional practices of the firm worldwide. He has worked extensively with executives to increase their understanding of information in the management function

The information revolution is sweeping through our economy. No company can escape its effects. Dramatic reductions in the cost of obtaining, processing, and transmitting information are changing the way we do business.

Most general managers know that the revolution is under way, and few dispute its importance. As more and more of their time and investment capital is absorbed in information technology and its effects, executives have a growing awareness that the technology can no longer be the exclusive territory of EDP or IS departments. As they see their rivals use information for competitive advantage, these executives recognize the need to become directly involved in the management of the new technology. In the face of rapid change, however, they don't know how.

This article aims to help general managers respond to the challenges of the information revolution. How will advances in information technology affect competition and the sources of competitive advantage? What strategies should a company pursue to exploit the technology? What are the implications of actions that competitors may already have taken? Of the many opportunities for investment in information technology, which are the most urgent?

To answer these questions, managers must first understand that information technology is more than just computers. Today, information technology must be conceived of broadly to encompass the information that businesses create and use as well as a wide spectrum of increasingly convergent and linked technologies that process the information. In addition to computers, then, data recognition equipment, com-

Authors' note We wish to thank Monitor Company and Arthur Andersen for their assistance in preparing this article. F Warren McFarlan also provided valuable comments.

Editor's note. All references appear at the end of the article

munications technologies, factory automation, and other hardware and services are involved.

The information revolution is affecting competition in three vital ways:

It changes industry structure and, in so doing, alters the rules of competition.

It creates competitive advantage by giving companies new ways to outperform their rivals.

It spawns whole new businesses, often from within a company's existing operations.

We discuss the reasons why information technology has acquired strategic significance and how it is affecting all businesses. We then describe how the new technology changes the nature of competition and how astute companies have exploited this. Finally, we outline a procedure managers can use to assess the role of information technology in their business and to help define investment priorities to turn the technology to their competitive advantage.

Strategic significance

Information technology is changing the way companies operate. It is affecting the entire process by which companies create their products. Furthermore, it is reshaping the product itself: the entire package of physical goods, services, and information companies provide to create value for their buyers.

An important concept that highlights the role of information technology in competition is the "value chain."[1] This concept divides a company's activities into the technologically and economically distinct activities it performs to do business. We call these "value activities." The value a company creates is measured by the amount that buyers are willing to pay for a product or service. A business is profitable if the value it creates exceeds the cost of performing the value activities. To gain competitive advantage over its rivals, a company must either perform these activities at a lower cost or perform them in a way that leads to differentiation and a premium price (more value).[2]

A company's value activities fall into nine generic categories (see *Exhibit I*). Primary activities are those involved in the physical creation of the product, its marketing and delivery to buyers, and its support and servicing after sale. Support activities provide the inputs and infrastructure that allow the primary activities to take place. Every activity employs purchased inputs, human resources, and a combination of technologies. Firm infrastructure, including such functions as general management, legal work, and accounting, supports the entire chain. Within each of these generic categories, a company will perform a number of discrete activities, depending on the particular business. Service, for example, frequently includes activities such as installation, repair, adjustment, upgrading, and parts inventory management.

A company's value chain is a system of interdependent activities, which are connected by linkages. Linkages exist when the way in which one activity is performed affects the cost or effectiveness of other activities. Linkages often create trade-offs in performing different activities that should be optimized. This optimization may require trade-offs. For example, a more costly product design and more expensive raw materials can reduce after-sale service costs. A company must resolve such trade-offs, in accordance with its strategy, to achieve competitive advantage.

Linkages also require activities to be coordinated. On-time delivery requires that operations, outbound logistics, and service activities (installation, for example) should function smoothly together. Good coordination allows on-time delivery without the need for costly inventory. Careful management of linkages is often a powerful source of competitive advantage because of the difficulty rivals have in perceiving them and in resolving trade-offs across organizational lines.

The value chain for a company in a particular industry is embedded in a larger stream of activities that we term the "value system" (see *Exhibit II*). The value system includes the value chains of suppliers, who provide inputs (such as raw materials, components, and purchased services) to the company's value chain. The company's product often passes through its channels' value chains on its way to the ultimate buyer. Finally, the product becomes a purchased input to the value chains of its buyers, who use it to perform one or more buyer activities.

Linkages not only connect value activities inside a company but also create interdependencies between its value chain and those of its suppliers and channels. A company can create competitive advantage by optimizing or coordinating these links to the outside. For example, a candy manufacturer may save processing steps by persuading its suppliers to deliver chocolate in liquid form rather than in molded bars. Just-in-time deliveries by the supplier may have the same effect. But the opportunities for savings through coordinating with suppliers and channels go far beyond logistics and order processing. The company, suppliers, and channels can all benefit through better recognition and exploitation of such linkages

Competitive advantage in either cost or differentiation is a function of a company's value

Exhibit I **The value chain**

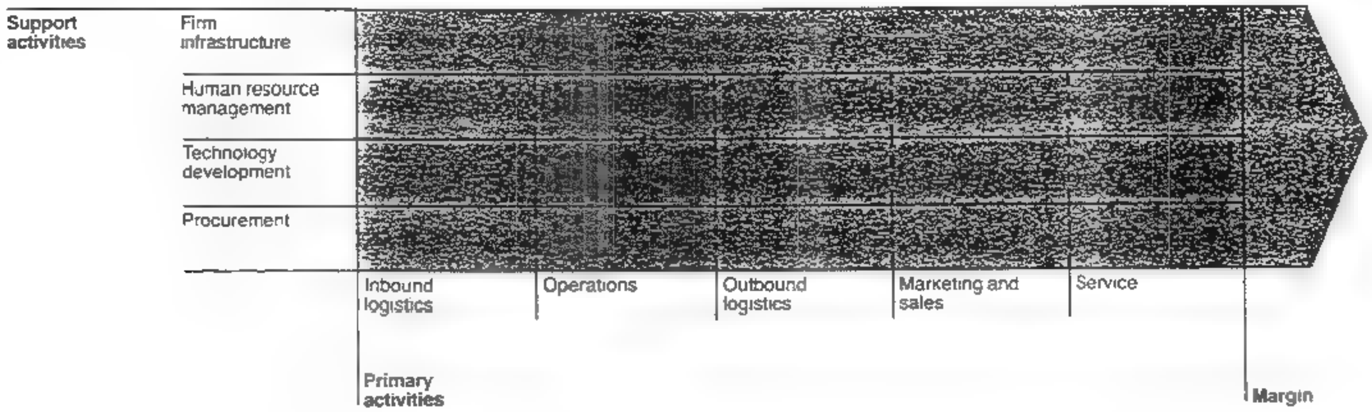
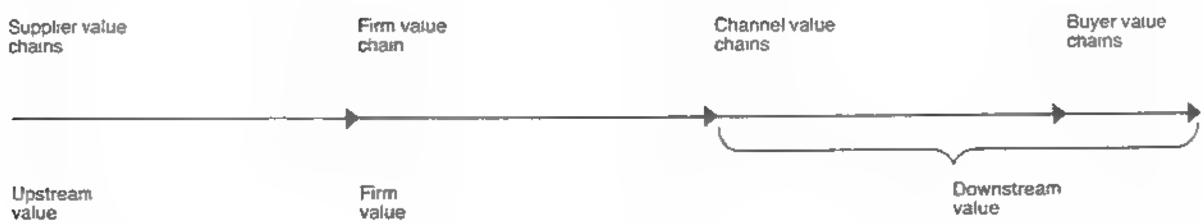


Exhibit II **The value system**



chain. A company's cost position reflects the collective cost of performing all its value activities relative to rivals. Each value activity has cost drivers that determine the potential sources of a cost advantage. Similarly, a company's ability to differentiate itself reflects the contribution of each value activity toward fulfillment of buyer needs. Many of a company's activities—not just its physical product or service—contribute to differentiation. Buyer needs, in turn, depend not only on the impact of the company's product on the buyer but also on the company's other activities (for example, logistics or after-sale services).

In the search for competitive advantage, companies often differ in competitive scope—or the breadth of their activities. Competitive scope has four key dimensions: segment scope, vertical scope (degree of vertical integration), geographic scope, and industry scope (or the range of related industries in which the company competes).

Competitive scope is a powerful tool for creating competitive advantage. Broad scope can allow the company to exploit interrelationships between the value chains serving different industry segments, geographic areas, or related industries. For example, two business units may share one sales force to sell their products, or the units may coordinate the procurement of common components. Competing nationally or globally with a coordinated strategy can yield a competitive advantage over local or domestic rivals. By employing a broad vertical scope, a company can exploit the potential benefits of performing more activities internally rather than use outside suppliers.

By selecting a narrow scope, on the other hand, a company may be able to tailor the value chain to a particular target segment to achieve lower cost or differentiation. The competitive advantage of a narrow scope comes from customizing the value chain to best serve particular product varieties, buyers, or geographic regions. If the target segment has unusual needs, broad-scope competitors will not serve it well.

Transforming the value chain

Information technology is permeating the value chain at every point, transforming the way value activities are performed and the nature of the

linkages among them. It also is affecting competitive scope and reshaping the way products meet buyer needs. These basic effects explain why information technology has acquired strategic significance and is different from the many other technologies businesses use.

Every value activity has both a physical and an information-processing component. The physical component includes all the physical tasks required to perform the activity. The information-processing component encompasses the steps required to capture, manipulate, and channel the data necessary to perform the activity.

Every value activity creates and uses information of some kind. A logistics activity, for example, uses information like scheduling promises, transportation rates, and production plans to ensure timely and cost-effective delivery. A service activity uses information about service requests to schedule calls and order parts, and generates information on product failures that a company can use to revise product designs and manufacturing methods.

An activity's physical and information-processing components may be simple or quite complex. Different activities require a different mix of the two components. For instance, metal stamping uses more physical processing than information processing; processing of insurance claims requires just the opposite balance.

For most of industrial history, technological progress principally affected the physical component of what businesses do. During the Industrial Revolution, companies achieved competitive advantage by substituting machines for human labor. Information processing at that time was mostly the result of human effort.

Now the pace of technological change is reversed. Information technology is advancing faster than technologies for physical processing. The costs of information storage, manipulation, and transmittal are falling rapidly and the boundaries of what is feasible in information processing are at the same time expanding. During the Industrial Revolution, the railroad cut the travel time from Boston, Massachusetts to Concord, New Hampshire from five days to four hours, a factor of 30.[3] But the advances in information technology are even greater. The cost of computer power relative to the cost of manual information processing is at least 8,000 times less expensive than the cost 30 years ago. Between 1958 and 1980 the time for one electronic operation fell by a factor of 80 million. Department of Defense studies show that the error rate in recording data through bar coding is 1 in 3,000,000, compared to 1 error in 300 manual data entries.[4]

This technological transformation is expanding the limits of what companies can do faster than managers can explore the opportunities. The information revolution affects all nine categories of value activity, from allowing computer-aided design in technology development to incorporating automation in warehouses (see *Exhibit III*). The new technology substitutes machines for human effort in information processing. Paper ledgers and rules of thumb have given way to computers.

Initially, companies used information technology mainly for accounting and record-keeping functions. In these applications, the computers automated repetitive clerical functions such as order processing. Today information technology is spreading throughout the value chain and is performing optimization and control functions as well as more judgmental executive functions. General Electric, for instance, uses a data base that includes the accumulated experience and (often intuitive) knowledge of its appliance service engineers to provide support to customers by phone.

Information technology is generating more data as a company performs its activities and is permitting it to collect or capture information that was not available before. Such technology also makes room for a more comprehensive analysis and use of the expanded data. The number of variables that a company can analyze or control has grown dramatically. Hunt-Wesson, for example, developed a computer model to aid it in studying distribution-center expansion and relocation issues. The model enabled the company to evaluate many more different variables, scenarios, and alternative strategies than had been possible before. Similarly, information technology helped Sulzer Brothers' engineers improve the design of diesel engines in ways that manual calculations could not.

Information technology is also transforming the physical processing component of activities. Computer-controlled machine tools are faster, more accurate, and more flexible in manufacturing than the older, manually operated machines. Schlumberger has developed an electronic device permitting engineers to measure the angle of a drill bit, the temperature of a rock, and other variables while drilling oil wells. The result: drilling time is reduced and some well-logging steps are eliminated. On the West Coast, some fishermen now use weather satellite data on ocean temperatures to identify promising fishing grounds. This practice greatly reduces the fishermen's steaming time and fuel costs.

Information technology not only affects how individual activities are performed but, through new information flows, it is also greatly enhancing a company's ability to exploit linkages between activities, both within and outside the company. The technology is creating new linkages between activities, and companies can now coordinate their actions more closely with those of their buyers and suppliers. For example, McKesson, the nation's largest drug distributor,

Exhibit III **Information Technology permeates the value chain**

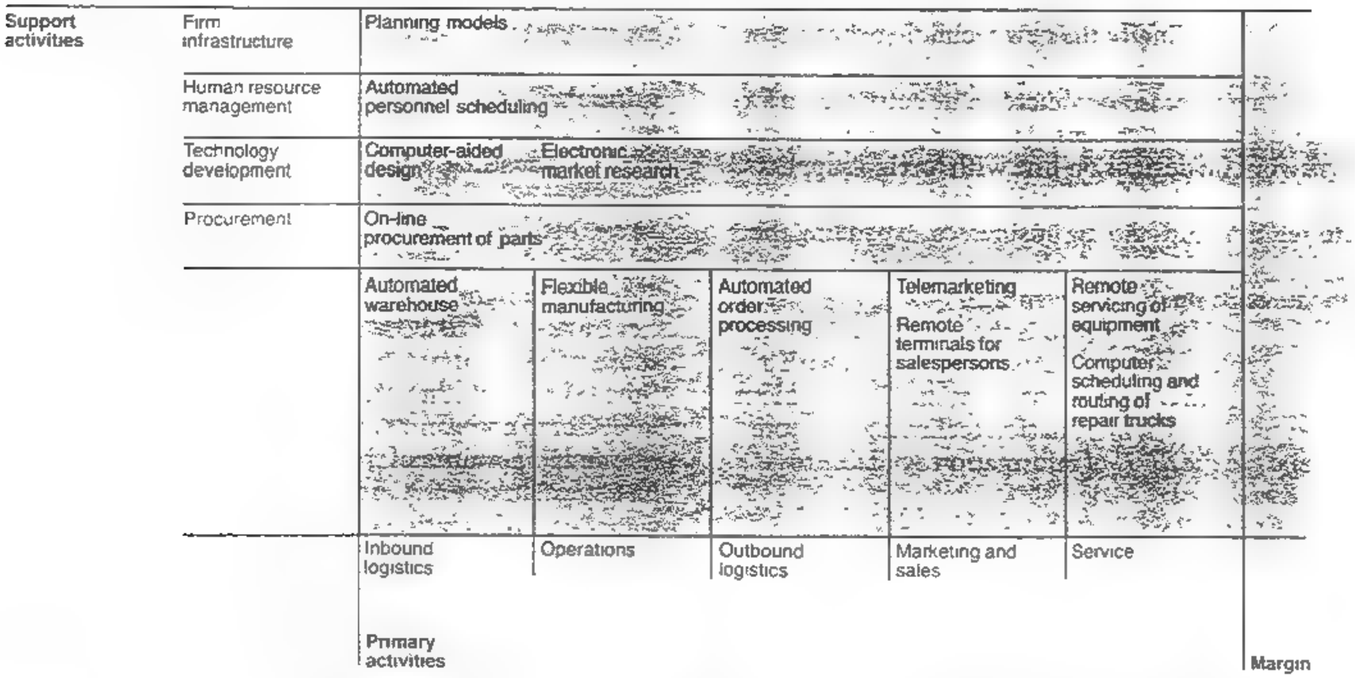


Exhibit IV **Information intensity matrix**

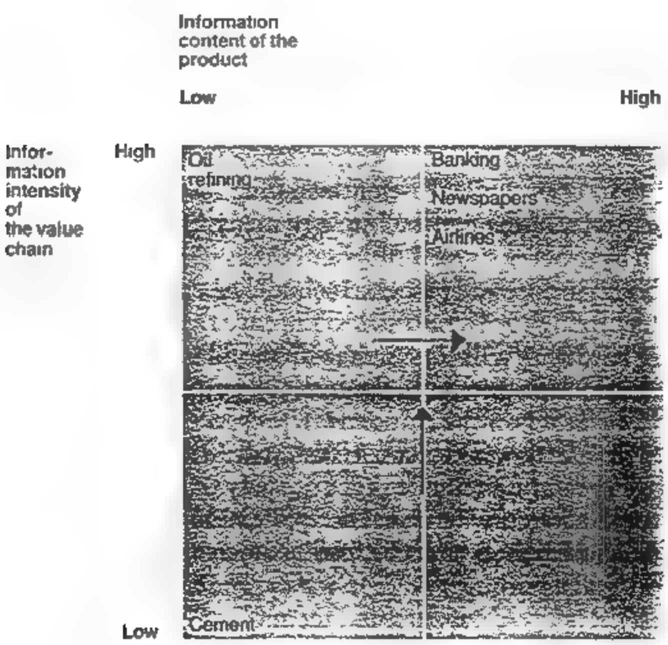
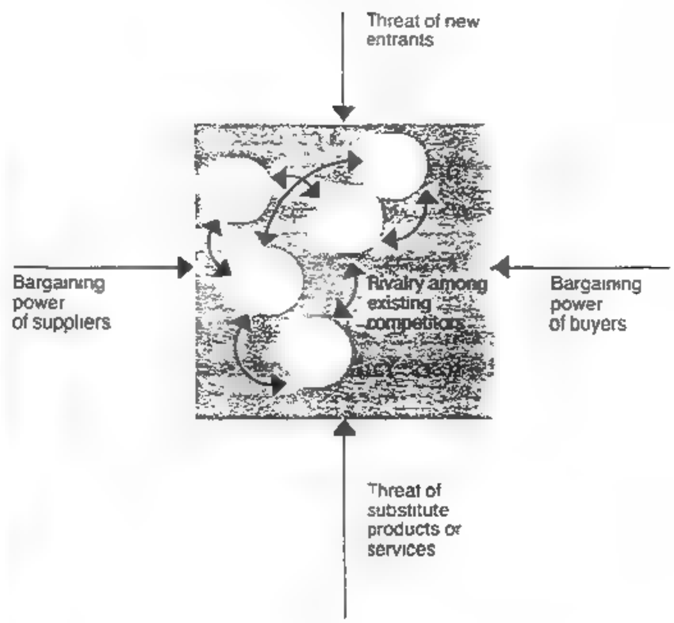


Exhibit V **Determinants of industry attractiveness**



provides its drugstore customers with terminals. The company makes it so easy for clients to order, receive, and prepare invoices that the customers, in return, are willing to place larger orders. At the same time, McKesson has streamlined its order processing.

Finally, the new technology has a powerful effect on competitive scope. Information systems allow companies to coordinate value activities in far-flung geographic locations. (For example, Boeing engineers work on designs on-line with foreign suppliers.) Information technology is also creating many new interrelationships among businesses, expanding the scope of industries in which a company must compete to achieve competitive advantage.

So pervasive is the impact of information technology that it confronts executives with a tough problem: too much information. This problem creates new uses of information technology to store and analyze the flood of information available to executives.

Transforming the product

Most products have always had both a physical and an information component. The latter, broadly defined, is everything that the buyer needs to know to obtain the product and use it to achieve the desired result. That is, a product includes information about its characteristics and how it should be used and supported. For example, convenient, accessible information on maintenance and service procedures is an important buyer criterion in consumer appliances.

Historically, a product's physical component has been more important than its information component. The new technology, however, makes it feasible to supply far more information along with the physical product. For example, General Electric's appliance service data base supports a consumer hotline that helps differentiate GE's service support from its rivals'. Similarly, some railroad and trucking companies offer up-to-the-minute information on the whereabouts of shippers' freight, which improves coordination between shippers and the railroad. The new technology is also making it increasingly possible to offer products with no physical component at all. Compustat's customers have access to corporate financial data filed with the Securities and Exchange Commission, and many companies have sprung up to perform energy use analyses of buildings.

Many products also process information in their normal functioning. A dishwasher, for example, requires a control system that directs the various components of the unit through the washing cycle and displays the process to the user. The new information technology is enhancing product performance and is making it easier to boost a product's information content. Electronic control of the automobile, for example, is becoming more visible in dashboard displays, talking dashboards, diagnostic messages, and the like.

There is an unmistakable trend toward expanding the information content in products. This component, combined with changes in companies' value chains, underscores the increasingly strategic role of information technology. There are no longer mature industries; rather, there are mature ways of doing business.

Direction & pace of change

Although a trend toward information intensity in companies and products is evident, the role and importance of the technology differs in each industry. Banking and insurance, for example, have always been information intensive. Such industries were naturally among the first and most enthusiastic users of data processing. On the other hand, physical processing will continue to dominate in industries that produce, say, cement, despite increased information processing in such businesses.

Exhibit IV, which relates information intensity in the value chain to information content in the product, illuminates the differences in the role and intensity of information among various industries. The banking and newspaper industries have a high information-technology content in both product and process. The oil-refining industry has a high use of information in the refining process but a relatively low information content in the product dimension.

Because of the falling cost and growing capacity of the new technology, many industries seem to be moving toward a higher information content in both product and process. It should be emphasized that technology will continue to improve rapidly. The cost of hardware will continue to drop, and managers will continue to distribute the technology among even the lower levels of the company. The cost of developing software, now a key constraint, will fall as more packages become available that are easily tailored to customers' circumstances. The applications of information technology that companies are using today are only a beginning.

Information technology is not only transforming products and processes but also the nature of competition itself. Despite the growing use of information technology, industries will always differ in their position in *Exhibit IV* and their pace of change.

Changing the nature of competition

After surveying a wide range of industries, we find that information technology is changing the rules of competition in three ways. First, advances in information technology are changing the industry structure. Second, information technology is an increasingly important lever that companies can use to create competitive advantage. A company's search for competitive advantage through information technology often also spreads to affect industry structure as competitors imitate the leader's strategic innovations. Finally, the information revolution is spawning completely new businesses. These three effects are critical for understanding the impact of information technology on a particular industry and for formulating effective strategic responses.

Changing industry structure

The structure of an industry is embodied in five competitive forces that collectively determine industry profitability: the power of buyers, the power of suppliers, the threat of new entrants, the threat of substitute products, and the rivalry among existing competitors (see *Exhibit V*). The collective strength of the five forces varies from industry to industry, as does average profitability. The strength of each of the five forces can also change, either improving or eroding the attractiveness of an industry.[5]

Information technology can alter each of the five competitive forces and, hence, industry attractiveness as well. The technology is unfreezing the structure of many industries, creating the need and opportunity for change. For example:

☐ Information technology increases the power of buyers in industries assembling purchased components. Automated bills for materials and vendor quotation files make it easier for buyers to evaluate sources of materials and make-or-buy decisions.

☐ Information technologies requiring large investments in complex software have raised the barriers to entry. For example, banks competing in cash management services for corporate clients now need advanced software to give customers on-line account information. These banks may also need to invest in improved computer hardware and other facilities.

☐ Flexible computer-aided design and manufacturing systems have influenced the threat of substitution in many industries by making it quicker, easier, and cheaper to incorporate enhanced features into products.

☐ The automation of order processing and customer billing has increased rivalry in many distribution industries. The new technology raises fixed costs at the same time as it displaces people. As a result, distributors must often fight harder for incremental volume.

Industries such as airlines, financial services, distribution, and information suppliers (see the

Information technology and industry structure

Buyer power	Videotex home shopping services, such as Comp-U-Card, increase buyers' information. Buyers use their personal computers to browse through electronic catalogs and compare prices and product specifications. Customers can make purchases at any hour at prices typically 25% to 30% below suggested retail levels. Comp-U-Card is growing quickly: revenues have quintupled in two years to $9.5 million and membership is now 15,000. According to some projections, by the mid-1990s, 75% of U.S. households will have access to such services.
Buyer power	Shelternet, an electronic information exchange offered by First Boston Corporation, allows real estate brokers to determine quickly and easily what mortgage packages are available and whether the buyer will qualify for financing. This improves the position of both brokers and homebuyers in shopping for mortgages. The parties can make preliminary commitments within 30 minutes.
Substitution	Electronic data bases, such as NEXIS, are substituting for library research and consulting firms. NEXIS subscribers can quickly search the full text of any article in 225 periodicals. Users drastically reduce the time spent in literature searches. In addition, the buyer avoids the cost of journal subscriptions and pays only for the information required.

upper right-hand corner of *Exhibit IV*) have felt these effects so far.[6] (See the insert, "Information Technology and Industry Structure," for more examples.)

Information technology has had a particularly strong impact on bargaining relationships between suppliers and buyers since it affects the linkages between companies and their suppliers, channels, and buyers. Information systems that cross company lines are becoming common. In some cases, the boundaries of industries themselves have changed.[7]

Systems that connect buyers and suppliers are spreading. Xerox gives manufacturing data to suppliers electronically to help them deliver materials. To speed up order entry, Westinghouse Electric Supply Company and American Hospital Supply have furnished their customers with terminals. Among other things, many systems raise the costs of switching to a new partner because of the disruption and retraining required. These systems tend to tie companies more closely to their buyers and suppliers.

Information technology is altering the relationship among scale, automation, and flexibility with potentially profound consequences. Large-scale production is no longer essential to achieve automation. As a result, entry barriers in a number of industries are falling.

At the same time, automation no longer necessarily leads to inflexibility. For example, General Electric rebuilt its Erie locomotive facility as a large-scale yet flexible factory using computers to store all design and manufacturing data. Ten types of motor frames can be accommodated without manual adjustments to the machines. After installation of a "smart" manufacturing system, BMW can build customized cars (each with its own tailored gearbox, transmission system, interior, and other features) on the normal assembly line. Automation and flexibility are achieved simultaneously, a pairing that changes the pattern of rivalry among competitors.

The increasing flexibility in performing many value activities combined with the falling costs of designing products has triggered an avalanche of opportunities to customize and to serve small market niches. Computer-aided design capability not only reduces the cost of designing new products but also dramatically reduces the cost of modifying or adding features to existing products. The cost of tailoring products to market segments is falling, again affecting the pattern of industry rivalry.

While managers can use information technology to improve their industry structure, the technology also has the potential to destroy that structure. For example, information systems now permit the airline industry to alter fares frequently and to charge many different fares between any two points. At the same time, however, the technology makes the flight and fare schedules more readily available and allows travel agents and individuals to shop around quickly for the lowest fare. The result is a lower fare structure than might otherwise exist. Information technology has made a number of professional service industries less attractive by reducing personal interaction and making service more of a commodity. Managers must look carefully at the structural implications of the new technology to realize its advantages or to be prepared for its consequences.

Creating competitive advantage

In any company, information technology has a powerful effect on competitive advantage in either cost or differentiation. The technology affects value activities themselves or allows companies to gain competitive advantage by exploiting changes in competitive scope.

Lowering cost. As we have seen, information technology can alter a company's costs in any part of the value chain.[8] The technology's historical impact on cost was confined to activities in which repetitive information processing played a large part. These limits no longer exist, however. Even activities like assembly that mainly involve physical processing now have a large information-processing component.

Canon, for example, built a low-cost copier assembly process around an automated parts-selection and materials-handling system. Assembly workers have bins containing all the parts needed for the particular copier. Canon's success with this system derives from the software that controls parts inventory and selection. In insurance brokerage, a number of insurance companies usually participate in underwriting a contract. The costs of documenting each company's participation are high. Now a computer model can optimize (and often reduce) the number of insurers per contract, lowering the broker's total cost. In garment production, equipment such as automated pattern drawers, fabric cutters, and systems for delivering cloth to the final sewing station have reduced the labor time for manufacturing by up to 50%. (See the insert, "Aim: A Competitive Edge," for further examples.)

In addition to playing a direct role in cost, information technology often alters the cost drivers of activities in ways that can improve (or erode) a company's relative cost position. For example, Louisiana Oil & Tire has taken all ten of its salespeople off the road and made them into telemarketers. As a result, sales expenses have fallen by 10% and sales volume has doubled. However, the move has made the national scale of operations the key determinant of the cost of selling, rather than regional scale.

Aim: a competitive edge

Lowering Cost	Casinos spend up to 20% of revenues on complimentary services for high rollers. One assignment for pit bosses has always been to keep an eye out for the big spenders. Now, however, many casinos have developed computer systems to analyze data on customers. Caesar's Palace lowered its complimentary budget more than 20% by developing a player-rating system for more accurate identification of big spenders
Enhancing Differentiation	American Express has developed differentiated travel services for corporate customers through the use of information technology The services include arranging travel and close monitoring of individual expenses. Computers search for the lowest airplane fares, track travel expenses for each cardholder, and issue monthly statements.

Enhancing differentiation. The impact of information technology on differentiation strategies is equally dramatic. As noted earlier, the role of a company and its product in the buyer's value chain is the key determinant of differentiation. The new information technology makes it possible to customize products. Using automation, for instance, Sulzer Brothers has increased from five to eight the number of cylinder bore sizes of new low-speed marine diesel engines. Shipowners now choose an engine that is more precisely suited to their needs and thereby recoup significant fuel savings. Similarly, Digital Equipment's artificial intelligence system, XCON, uses decision rules to develop custom computer configurations. This dramatically reduces the time required to fill orders and increases accuracy—which enhances Digital's image as a quality provider.

By bundling more information with the physical product package sold to the buyer, the new technology affects a company's ability to differentiate itself. For example, a magazine distributor offers retailers processing credits for unsold items more efficiently than its competitors. Similarly, the embedding of information systems in the physical product itself is an increasingly powerful way to distinguish it from competing goods.

Changing competitive scope. Information technology can alter the relationship between competitive scope and competitive advantage. The technology increases a company's ability to coordinate its activities regionally, nationally, and globally. It can unlock the power of broader geographic scope to create competitive advantage. Consider the newspaper industry. Dow Jones, publisher of the *Wall Street Journal*, pioneered the page transmission technology that links its 17 U.S printing plants to produce a truly national newspaper. Such advances in communication plants have also made it possible to move toward a global strategy. Dow Jones has started the *Asian Wall Street Journal* and the *Wall Street Journal-European Edition* and shares much of the editorial content while printing the papers in plants all over the world.

The information revolution is creating interrelationships among industries that were previously separate. The merging of computer and telecommunications technologies is an important example. This convergence has profound effects on the structure of both industries. For example, AT&T is using its position in telecommunications as a staging point for entry into the computer industry. IBM, which recently acquired Rolm, the telecommunications equipment manufacturer, is now joining the competition from the other direction. Information technology is also at the core of growing interrelationships in financial services, where the banking, insurance, and brokerage industries are merging, and in office equipment, where once distinct functions such as typing, photocopying, and data and voice communications can now be combined.

Broad-line companies are increasingly able to segment their offerings in ways that were previously feasible only for focused companies. In the trucking industry, Intermodal Transportation Services, Inc. of Cincinnati has completely changed its system for quoting prices. In the past, each local office set prices using manual procedures. Intermodal now uses microcomputers to link its offices to a center that calculates all prices. The new system gives the company the capacity to introduce a new pricing policy to offer discounts to national accounts, which place their orders from all over the country. Intermodal is tailoring its value chain to large national customers in a way that was previously impossible.

As information technology becomes more widespread, the opportunities to take advantage of a new competitive scope will only increase. The benefits of scope (and the achievement of linkages), however, can accrue only when the information technology spread throughout the organization can communicate. Completely decentralized organizational design and application of information technology will thwart these possibilities, because the information technology introduced in various parts of a company will not be compatible.

Spawning new businesses

The information revolution is giving birth to completely new industries in three distinct ways. First, it makes new businesses technologically feasible. For example, modern imaging and telecommunications technology blend to support new facsimile services such as Federal Express's Zapmail. Similarly, advances in microelectronics made personal computing possible. Services such as Merrill Lynch's Cash Management Account required new information technology to combine several financial products into one

Second, information technology can also spawn new businesses by creating derived demand for new products. One example is Western Union's EasyLink service, a sophisticated, high-speed, data-communications network that allows personal computers, word processors, and other electronic devices to send messages to each other and to telex machines throughout the world. This service was not needed before the spread of information technology caused a demand for it.

Third, information technology creates new businesses within old ones. A company with information processing embedded in its value chain may have excess capacity or skills that can be sold outside. Sears took advantage of its skills in processing credit card accounts and of its massive scale to provide similar services to others. It sells credit-authorization and transaction-processing services to Phillips Petroleum and retail remittance-processing services to Mellon Bank. Similarly, a manufacturer of automotive parts, A.O. Smith, developed data-communications expertise to meet the needs of its traditional businesses. When a bank consortium went looking for a contractor to run a network of automated teller machines, A.O. Smith got the job. Eastman Kodak recently began offering long-distance telephone and data-transmission services through its internal telecommunications system. Where the information technology used in a company's value chain is sensitive to scale, a company may improve its overall competitive advantage by increasing the scale of information processing and lowering costs. By selling extra capacity outside, it is at the same time generating new revenue.

Companies also are increasingly able to create and sell to others information that is a by-product of their operations. National Benefit Life reportedly merged with American Can in part to gain access to data on the nine million customers of American Can's direct-mail retailing subsidiary. The use of bar-code scanners in supermarket retailing has turned grocery stores into market research labs. Retailers can run an ad in the morning newspaper and find out its effect by early afternoon. They can also sell this data to market research companies and to food processors

Competing in the age of information

Senior executives can follow five steps to take advantage of opportunities that the information revolution has created.

1 **Assess information intensity.** A company's first task is to evaluate the existing and potential information intensity of the products and processes of its business units. To help managers accomplish this, we have developed some measures of the potential importance of information technology.

It is very likely that information technology will play a strategic role in an industry that is characterized by one or more of the following features:

☐ Potentially high information intensity in the value chain—a large number of suppliers or customers with whom the company deals directly, a product requiring a large quantity of information in selling, a product line with many distinct product varieties, a product composed of many parts, a large number of steps in a company's manufacturing process, a long cycle time from the initial order to the delivered product.

☐ Potentially high information intensity in the product—a product that mainly provides information, a product whose operation involves substantial information processing, a product whose use requires the buyer to process a lot of information, a product requiring especially high costs for buyer training, a product that has many alternative uses or is sold to a buyer with high information intensity in his or her own business.

These may help identify priority business units for investment in information technology. When selecting priority areas, remember the breadth of information technology—it involves more than simple computing.

2 **Determine the role of information technology in industry structure.** Managers should predict the likely impact of information technology on their industry's structure. They must examine how information technology might affect each of the five competitive forces. Not only is each force likely to change but

industry boundaries may change as well. Chances are that a new definition of the industry may be necessary.

Many companies are partly in control of the nature and pace of change in the industry structure. Companies have permanently altered the bases of competition in their favor in many industries through aggressive investments in information technology and have forced other companies to follow. Citibank, with its automated teller machines and transaction processing; American Airlines, with its computerized reservations system; and *USA Today*, with its newspaper page transmission to decentralized printing plants, are pioneers that have used information technology to alter industry structure. A company should understand how structural change is forcing it to respond and look for ways to lead change in the industry.

3 **Identify and rank the ways in which information technology might create competitive advantage.** The starting assumption must be that the technology is likely to affect every activity in the value chain. Equally important is the possibility that new linkages among activities are being made possible. By taking a careful look, managers can identify the value activities that are likely to be most affected in terms of cost and differentiation. Obviously, activities that represent a large proportion of cost or that are critical to differentiation bear closest scrutiny, particularly if they have a significant information-processing component. Activities with important links to other activities inside and outside the company are also critical. Executives must examine such activities for ways in which information technology can create sustainable competitive advantage.

In addition to taking a hard look at its value chain, a company should consider how information technology might allow a change in competitive scope. Can information technology help the company serve new segments? Will the flexibility of information technology allow broad-line competitors to invade areas that were once the province of niche competitors? Will information technology provide the leverage to expand the business globally? Can managers harness information technology to exploit interrelationships with other industries? Or, can the technology help a company create competitive advantage by narrowing its scope?

A fresh look at the company's product may also be in order:

Can the company bundle more information with the product?

Can the company embed information technology in it?

4 **Investigate how information technology might spawn new businesses.** Managers should consider opportunities to create new businesses from existing ones. Information technology is an increasingly important avenue for corporate diversification. Lockheed, for example, entered the data base business by perceiving an opportunity to use its spare computer capacity.

Identifying opportunities to spawn new businesses requires answering questions such as:

What information generated (or potentially generated) in the business could the company sell?

What information-processing capacity exists internally to start a new business?

Does information technology make it feasible to produce new items related to the company's product?

5 **Develop a plan for taking advantage of information technology.** The first four steps should lead to an action plan to capitalize on the information revolution. This action plan should rank the strategic investments necessary in hardware and software, and in new product development activities that reflect the increasing information content in products. Organizational changes that reflect the role that the technology plays in linking activities inside and outside the company are likely to be necessary.

The management of information technology can no longer be the sole province of the EDP department. Increasingly, companies must employ information technology with a sophisticated understanding of the requirements for competitive advantage. Organizations need to distribute the responsibility for systems development more widely in the organization. At the same time, general managers must be involved to ensure that cross-functional linkages, more possible to achieve with information technology, are exploited.

These changes do not mean that a central information-technology function should play an insignificant role. Rather than control information technology, however, an IS manager should coordinate the architecture and standards of the many applications throughout the organization, as well as provide assistance and coaching in systems development. Unless the numerous applications of information technology inside a company are compatible with each other, many benefits may be lost.

Information technology can help in the strategy implementation process. Reporting systems can track progress toward milestones and success factors. By using information systems, companies can

measure their activities more precisely and help motivate managers to implement strategies successfully.[9]

The importance of the information revolution is not in dispute. The question is not whether information technology will have a significant impact on a company's competitive position; rather the question is when and how this impact will strike. Companies that anticipate the power of information technology will be in control of events. Companies that do not respond will be forced to accept changes that others initiate and will find themselves at a competitive disadvantage.

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3 Alfred D. Chandler, Jr., *The Visible Hand* (Cambridge: Belknap Press of Harvard University Press, 1977), p. 86

4 James L. McKenney and F Warren McFarlan "The Information Archipelago – Maps and Bridges," HBR September-October 1982, p. 109

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7 James I. Cash, Jr. and Benn R. Konsynski, "IS Redraws Competitive Boundaries," HBR March-April 1985, p. 134

8 See Gregory L. Parsons, "Information Technology: A New Competitive Weapon," *Sloan Management Review*, Fall 1983, p. 3

9 Victor E. Millar, "Decision-Oriented Information," *Datamation*, January 1984, p. 159

Sears and the consensus

By the early 1920s, however, the "buyer for the American farmer" concept had begun to lose its relevance to economic and social realities. With the coming of the automobile and good roads, rural America rapidly became less isolated, and the kinds of merchandise of interest to the farm family came more and more to be the kinds of merchandise of interest to city dwellers as well. In this process, radio advertising also played a significant role. There was no longer a separately definable rural market with its own unique characteristics and needs; that market, and the previously distinct urban market, were homogenizing into a general American mass market.

The then managements of Sears and Ward's alike failed to grasp the significance of these new developments. They knew that their companies had problems, sales were increasingly difficult to get and profits were slipping.

Sears found the answer first – fortuitously. By bringing General Wood into the company in November of 1924, Julius Rosenwald acquired much more than the higher order of managerial skills he was seeking. He acquired a man who was capable of introducing a new entrepreneurial concept as fully responsive to the needs and opportunities of the times as Rosenwald's own had been to the needs and opportunities of a quarter-century earlier.

One of Wood's interesting personal traits was a fascination with census data. This had its origins during his years on the Canal, where good reading material – or, for that matter, any reading material – was scarce. The story is told that once, while confined to the infirmary with a minor ailment, the only thing Wood could find to read was the *Statistical Abstract of the United States*, which he began perusing simply to pass the time but soon came to study avidly. Whether or not the infirmary story is apocryphal, it is clear that in his Canal experience he acquired a taste for and an understanding of demographic and economic statistics that stayed with him for the rest of his life. During his mature years, there was a widely circulated myth (probably grounded in fact) that the *Statistical Abstract* was his favorite bedside reading. In any event, his keen grasp of major trends in American life was evident in his business planning and even ordinary conversation.

From *Shaping an American Institution: Robert E. Wood and Sears, Roebuck* by James C. Worthy (Urbana and Chicago, Ill.: University of Illinois Press)

as well as commented perceptively on the entire book. Others who have given generously of their time in commenting on the book and contributing ideas include Mark Albion, Robert Eccles, Douglas Anderson, Elon Kohlberg, and Richard Meyer, all Harvard colleagues. Michael Bell, Thomas Craig, Mary Kearney, and Mark Thomas have most ably worked with me in putting these ideas into practice, and contributed greatly to my thinking in the process. Jane Kenney Austin, Eric Evans, and Paul Rosetti were invaluable in commenting or in researching important topic areas. Finally, I have benefited from comments from colleagues at other schools, including Richard Schmalensee and John Stengrevics.

I could not have stood up under the demands of preparing this book without my assistant Kathleen Svensson. She has not only organized my activities but also supervised the preparation of the manuscript. I am also grateful to Robert Wallace, my editor, as well as to others at The Free Press, for their patience and support in dealing with a sometimes recalcitrant author. I must also thank my many able Harvard MBA and doctoral students who have both stimulated my thinking and been a source of joy in using these ideas. I also want to thank Deborah Zylberberg for her constant encouragement. Finally, I owe a great deal to a number of thoughtful practitioners who have shared their concerns and problems with me.

From: Competitive Advantage, Michael Porter, The Free Press, 1985, p1-26

1
Competitive Strategy: The Core Concepts

Competition is at the core of the success or failure of firms. Competition determines the appropriateness of a firm's activities that can contribute to its performance, such as innovations, a cohesive culture, or good implementation. Competitive strategy is the search for a favorable competitive position in an industry, the fundamental arena in which competition occurs. Competitive strategy aims to establish a profitable and sustainable position against the forces that determine industry competition.

Two central questions underlie the choice of competitive strategy. The first is the attractiveness of industries for long-term profitability and the factors that determine it. Not all industries offer equal opportunities for sustained profitability, and the inherent profitability of its industry is one essential ingredient in determining the profitability of a firm. The second central question in competitive strategy is the determinants of relative competitive position within an industry. In most industries, some firms are much more profitable than others,

regardless of what the average profitability of the industry may be.

Neither question is sufficient by itself to guide the choice of competitive strategy. A firm in a very attractive industry may still not earn attractive profits if it has chosen a poor competitive position. Conversely, a firm in an excellent competitive position may be in such a poor industry that it is not very profitable, and further efforts to enhance its position will be of little benefit.[1] Both questions are dynamic; industry attractiveness and competitive position change. Industries become more or less attractive over time, and competitive position reflects an unending battle among competitors. Even long periods of stability can be abruptly ended by competitive moves.

Both industry attractiveness and competitive position can be shaped by a firm, and this is what makes the choice of competitive strategy both challenging and exciting. While industry attractiveness is partly a reflection of factors over which a firm has little influence, competitive strategy has considerable power to make an industry more or less attractive. At the same time, a firm can clearly improve or erode its position within an industry through its choice of strategy. Competitive strategy, then, not only responds to the environment but also attempts to shape that environment in a firm's favor.

These two central questions in competitive strategy have been at the core of my research. My book *Competitive Strategy: Techniques for Analyzing Industries and Competitors* presents an analytical framework for understanding industries and competitors, and formulating an overall competitive strategy. It describes the five competitive forces that determine the attractiveness of an industry and their underlying causes, as well as how these forces change over time and can be influenced through strategy. It identifies three broad generic strategies for achieving competitive advantage. It also shows how to analyze competitors and to predict and influence their behavior, and how to map competitors into strategic groups and assess the most attractive positions in an industry. It then goes on to apply the framework to a range of important types of industry environments that I term *structural settings*, including fragmented industries, emerging industries, industries undergoing a transition to maturity, declining industries,

[1]Many strategic planning concepts have ignored industry attractiveness and stressed the pursuit of market share, often a recipe for pyrrhic victories. The winner in a fight for share in an unattractive industry may not be profitable, and the fight itself may make industry structure worse or erode the winner's profitability. Other planning concepts associate stalemates, or inability to get ahead of competitors, with unattractive profits. In fact, stalemates can be quite profitable in attractive industries.

and global industries. Finally, the book examines the important strategic decisions that occur in the context of an industry, including vertical integration, capacity expansion, and entry.

This book takes the framework in *Competitive Strategy* as a starting point. The central theme of this book is how a firm can actually create and sustain a competitive advantage in its industry—how it can implement the broad generic strategies. My aim is to build a bridge between strategy and implementation, rather than treat these two subjects independently or consider implementation scarcely at all as has been characteristic of much previous research in the field.

Competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceeds the firm's cost of creating it. Value is what buyers are willing to pay, and superior value stems from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price. There are two basic types of competitive advantage: cost leadership and differentiation. This book describes how a firm can gain a cost advantage or how it can differentiate itself. It describes how the choice of competitive scope, or the range of a firm's activities, can play a powerful role in determining competitive advantage. Finally, it translates these concepts, combined with those in my earlier book, into overall implications for offensive and defensive competitive strategy, including the role of uncertainty in influencing strategic choices. This book considers not only competitive strategy in an individual industry but also corporate strategy for the diversified firm. Competitive advantage in one industry can be strongly enhanced by interrelationships with business units competing in related industries, if these interrelationships can actually be achieved. Interrelationships among business units are the principal means by which a diversified firm creates value, and thus provide the underpinnings for corporate strategy. I will describe how interrelationships among business units can be identified and translated into a corporate strategy, as well as how interrelationships can be achieved in practice despite the organizational impediments to doing so that are present in many diversified firms.

Though the emphases of this book and my earlier book are different, they are strongly complementary. The emphasis of *Competitive Strategy* is on industry structure and competitor analysis in a variety of industry environments, though it contains many implications for competitive advantage. This book begins by assuming an understanding of industry structure and competitor behavior, and is preoccupied with how to translate that understanding into a competitive advantage.

Actions to create competitive advantage often have important consequences for industry structure and competitive reaction, however, and thus I will return to these subjects frequently.

This book can be read independently of *Competitive Strategy*, but its power to aid practitioners in formulating strategy is diminished if the reader is not familiar with the core concepts presented in the earlier book. In this chapter, I will describe and elaborate on some of those concepts. The discussion of the core concepts will also provide a good means of introducing the concepts and techniques in this book. In the process, I will address some of the most important questions that arise in applying the core concepts in practice. Thus even readers familiar with my earlier book may find the review of interest.

The Structural Analysis of Industries

The first fundamental determinant of a firm's profitability is industry attractiveness. Competitive strategy must grow out of a sophisticated understanding of the rules of competition that determine an industry's attractiveness. The ultimate aim of competitive strategy is to cope with and, ideally, to change those rules in the firm's favor. In any industry, whether it is domestic or international or produces a product or a service,[2] the rules of competition are embodied in five competitive forces: the entry of new competitors, the threat of substitutes, the bargaining power of buyers, the bargaining power of suppliers, and the rivalry among the existing competitors (see Figure 1–1).

The collective strength of these five competitive forces determines the ability of firms in an industry to earn, on average, rates of return on investment in excess of the cost of capital. The strength of the five forces varies from industry to industry, and can change as an industry evolves. The result is that all industries are not alike from the standpoint of inherent profitability. In industries where the five forces are favorable, such as pharmaceuticals, soft drinks, and data base publishing, many competitors earn attractive returns. But in industries where pressure from one or more of the forces is intense, such as rubber, steel, and video games, few firms command attractive

[2]These concepts apply equally to products and services. I will use the term "product" in the generic sense throughout this book to refer to both product and service industries

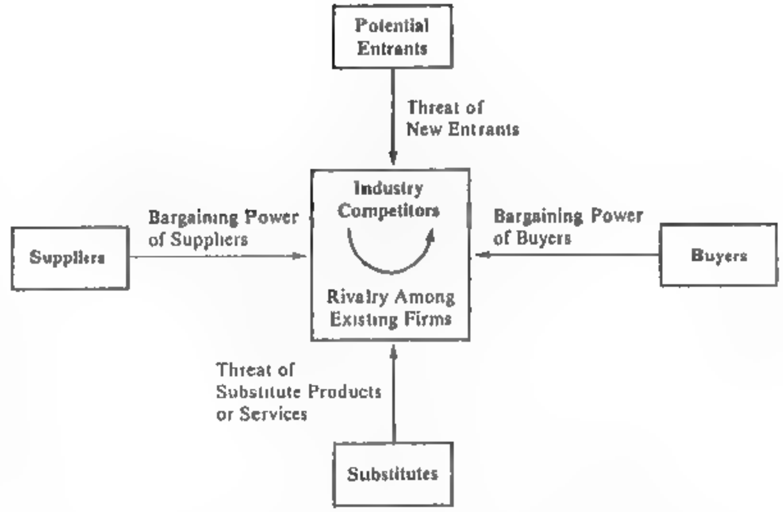


Figure 1–1. The Five Competitive Forces that Determine Industry Profitability

returns despite the best efforts of management. Industry profitability is not a function of what the product looks like or whether it embodies high or low technology, but of industry structure. Some very mundane industries such as postage meters and grain trading are extremely profitable, while some more glamorous, high-technology industries such as personal computers and cable television are not profitable for many participants.

The five forces determine industry profitability because they influence the prices, costs, and required investment of firms in an industry—the elements of return on investment. Buyer power influences the prices that firms can charge, for example, as does the threat of substitution. The power of buyers can also influence cost and investment, because powerful buyers demand costly service. The bargaining power of suppliers determines the costs of raw materials and other inputs. The intensity of rivalry influences prices as well as the costs of competing in areas such as plant, product development, advertising, and sales force. The threat of entry places a limit on prices, and shapes the investment required to deter entrants.

The strength of each of the five competitive forces is a function of *industry structure*, or the underlying economic and technical characteristics of an industry. Its important elements are shown in Figure

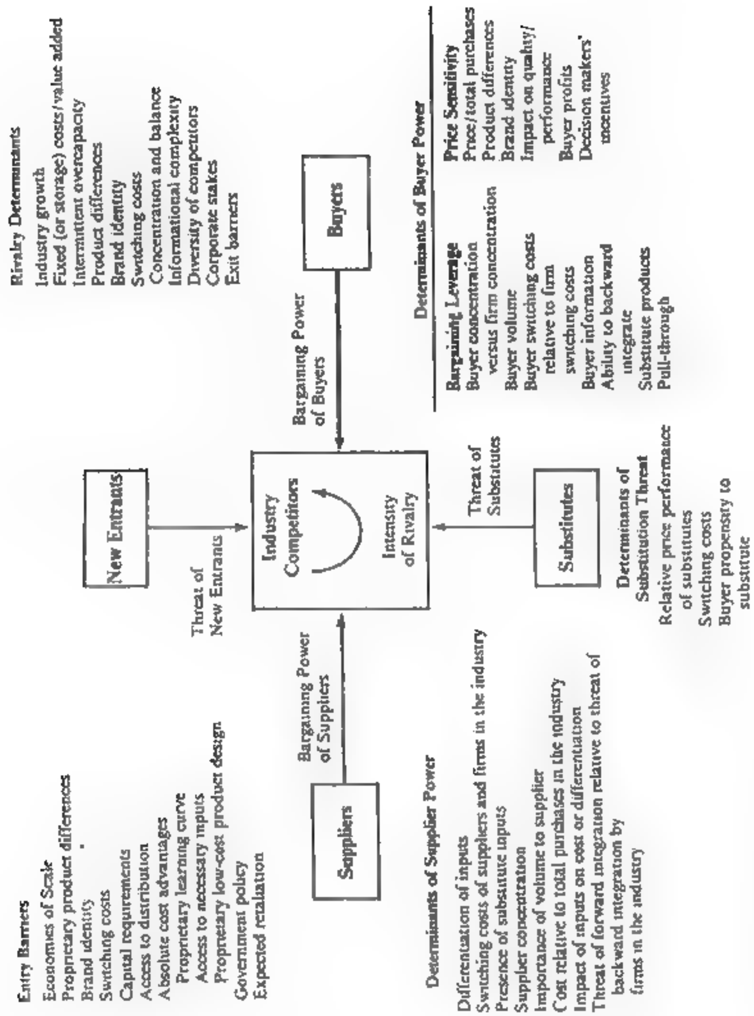


Figure 1–2. Elements of Industry Structure

1–2.[3] Industry structure is relatively stable, but can change over time as an industry evolves. Structural change shifts the overall and relative strength of the competitive forces, and can thus positively or negatively influence industry profitability. The industry trends that are the most important for strategy are those that affect industry structure.

If the five competitive forces and their structural determinants were solely a function of intrinsic industry characteristics, then competitive strategy would rest heavily on picking the right industry and understanding the five forces better than competitors. But while these are surely important tasks for any firm, and are the essence of competitive strategy in some industries, a firm is usually not a prisoner of its industry's structure. Firms, through their strategies, can influence the five forces. If a firm can shape structure, it can fundamentally change an industry's attractiveness for better or for worse. Many successful strategies have shifted the rules of competition in this way.

Figure 1–2 highlights all the elements of industry structure that may drive competition in an industry. In any particular industry, not all of the five forces will be equally important and the particular structural factors that are important will differ. Every industry is unique and has its own unique structure. The five-forces framework allows a firm to see through the complexity and pinpoint those factors that are critical to competition in its industry, as well as to identify those strategic innovations that would most improve the industry's—and its own—profitability. The five-forces framework does not eliminate the need for creativity in finding new ways of competing in an industry. Instead, it directs managers' creative energies toward those aspects of industry structure that are most important to long-run profitability. The framework aims, in the process, to raise the odds of discovering a desirable strategic innovation.

Strategies that change industry structure can be a double-edged sword, because a firm can destroy industry structure and profitability as readily as it can improve it. A new product design that undercuts entry barriers or increases the volatility of rivalry, for example, may undermine the long-run profitability of an industry, though the initiator may enjoy higher profits temporarily. Or a sustained period of price cutting can undermine differentiation. In the tobacco industry, for example, generic cigarettes are a potentially serious threat to industry structure. Generics may enhance the price sensitivity of buyers, trigger price competition, and erode the high advertising barriers that have kept out new entrants.[4] Joint ventures entered into by major aluminum

[3]Industry structure is discussed in detail in *Competitive Strategy*, Chapter 1.
[4]Generic products pose the same risks to many consumer good industries.

producers to spread risk and lower capital cost may have similarly undermined industry structure. The majors invited a number of potentially dangerous new competitors into the industry and helped them overcome the significant entry barriers to doing so. Joint ventures also can raise exit barriers because all the participants in a plant must agree before it can be closed down.

Often firms make strategic choices without considering the long-term consequences for industry structure. They see a gain in their competitive position if a move is successful, but they fail to anticipate the consequences of competitive reaction. If imitation of a move by major competitors has the effect of wrecking industry structure, then everyone is worse off. Such industry "destroyers" are usually second-tier firms that are searching for ways to overcome major competitive disadvantages, firms that have encountered serious problems and are desperately seeking solutions, or "dumb" competitors that do not know their costs or have unrealistic assumptions about the future. In the tobacco industry, for example, the Liggett Group (a distant follower) has encouraged the trend toward generics.

The ability of firms to shape industry structure places a particular burden on industry leaders. Leaders' actions can have a disproportionate impact on structure, because of their size and influence over buyers, suppliers, and other competitors. At the same time, leaders' large market shares guarantee that anything that changes overall industry structure will affect them as well. A leader, then, must constantly balance its own competitive position against the health of the industry as a whole. Often leaders are better off taking actions to improve or protect industry structure rather than seeking greater competitive advantage for themselves. Such industry leaders as Coca-Cola and Campbell's Soup appear to have followed this principle.

Industry Structure and Buyer Needs

It has often been said that satisfying buyer needs is at the core of success in business endeavor. How does this relate to the concept of industry structural analysis? Satisfying buyer needs is indeed a prerequisite to the viability of an industry and the firms within it. Buyers must be willing to pay a price for a product that exceeds its cost of production, or an industry will not survive in the long run. Chapter 4 will describe in detail how a firm can differentiate itself by satisfying buyer needs better than its competitors.

Satisfying buyer needs may be a prerequisite for industry profitability, but in itself is not sufficient. The crucial question in determining profitability is whether firms can capture the value they create for buyers, or whether this value is competed away to others. Industry structure determines who captures the value. The threat of entry determines the likelihood that new firms will enter an industry and compete away the value, either passing it on to buyers in the form of lower prices or dissipating it by raising the costs of competing. The power of buyers determines the extent to which they retain most of the value created for themselves, leaving firms in an industry only modest returns. The threat of substitutes determines the extent to which some other product can meet the same buyer needs, and thus places a ceiling on the amount a buyer is willing to pay for an industry's product. The power of suppliers determines the extent to which value created for buyers will be appropriated by suppliers rather than by firms in an industry. Finally, the intensity of rivalry acts similarly to the threat of entry. It determines the extent to which firms already in an industry will compete away the value they create for buyers among themselves, passing it on to buyers in lower prices or dissipating it in higher costs of competing.

Industry structure, then, determines who keeps what proportion of the value a product creates for buyers. If an industry's product does not create much value for its buyers, there is little value to be captured by firms regardless of the other elements of structure. If the product creates a lot of value, structure becomes crucial. In some industries such as automobiles and heavy trucks, firms create enormous value for their buyers but, on average, capture very little of it for themselves through profits. In other industries such as bond rating services, medical equipment, and oil field services and equipment, firms also create high value for their buyers but have historically captured a good proportion of it. In oil field services and equipment, for example, many products can significantly reduce the cost of drilling. Because industry structure has been favorable, many firms in the oil field service and equipment sector have been able to retain a share of these savings in the form of high returns. Recently, however, the structural attractiveness of many industries in the oil field services and equipment sector has eroded as a result of falling demand, new entrants, eroding product differentiation, and greater buyer price sensitivity. Despite the fact that products offered still create enormous value for the buyer, both firm and industry profits have fallen significantly.

Industry Structure and the Supply/Demand Balance

Another commonly held view about industry profitability is that profits are a function of the balance between supply and demand. If demand is greater than supply, this leads to high profitability. Yet, the long-term supply/demand balance is strongly influenced by industry structure, as are the consequences of a supply/demand imbalance for profitability. Hence, even though short-term fluctuations in supply and demand can affect short-term profitability, industry structure underlies long-term profitability.

Supply and demand change constantly, adjusting to each other. Industry structure determines how rapidly competitors add new supply. The height of entry barriers underpins the likelihood that new entrants will enter an industry and bid down prices. The intensity of rivalry plays a major role in determining whether existing firms will expand capacity aggressively or choose to maintain profitability. Industry structure also determines how rapidly competitors will retire excess supply. Exit barriers keep firms from leaving an industry when there is too much capacity, and prolong periods of excess capacity. In oil tanker shipping, for example, the exit barriers are very high because of the specialization of assets. This has translated into short peaks and long troughs of prices. Thus industry structure shapes the supply/demand balance and the duration of imbalances.

The consequences of an imbalance between supply and demand for industry profitability also differs widely depending on industry structure. In some industries, a small amount of excess capacity triggers price wars and low profitability. These are industries where there are structural pressures for intense rivalry or powerful buyers. In other industries, periods of excess capacity have relatively little impact on profitability because of favorable structure. In oil tools, ball valves, and many other oil field equipment products, for example, there has been intense price cutting during the recent sharp downturn. In drill bits, however, there has been relatively little discounting. Hughes Tool, Smith International, and Baker International are good competitors (see Chapter 6) operating in a favorable industry structure. Industry structure also determines the profitability of excess demand. In a boom, for example, favorable structure allows firms to reap extraordinary profits, while a poor structure restricts the ability to capitalize on it. The presence of powerful suppliers or the presence of substitutes, for example, can mean that the fruits of a boom pass to others. Thus industry structure is fundamental to both the speed of adjustment

of supply to demand and the relationship between capacity utilization and profitability.

Generic Competitive Strategies

The second central question in competitive strategy is a firm's relative position within its industry. Positioning determines whether a firm's profitability is above or below the industry average. A firm that can position itself well may earn high rates of return even though industry structure is unfavorable and the average profitability of the industry is therefore modest.

The fundamental basis of above-average performance in the long run is *sustainable competitive advantage.*[5] Though a firm can have a myriad of strengths and weaknesses vis-à-vis its competitors, there are two basic types of competitive advantage a firm can possess: low cost or differentiation. The significance of any strength or weakness a firm possesses is ultimately a function of its impact on relative cost or differentiation. Cost advantage and differentiation in turn stem from industry structure. They result from a firm's ability to cope with the five forces better than its rivals.

The two basic types of competitive advantage combined with the scope of activities for which a firm seeks to achieve them lead to three *generic strategies* for achieving above-average performance in an industry: cost leadership, differentiation, and focus. The focus strategy has two variants, cost focus and differentiation focus. The generic strategies are shown in Figure 1–3.

Each of the generic strategies involves a fundamentally different route to competitive advantage, combining a choice about the type of competitive advantage sought with the scope of the strategic target in which competitive advantage is to be achieved. The cost leadership and differentiation strategies seek competitive advantage in a broad range of industry segments, while focus strategies aim at cost advantage (cost focus) or differentiation (differentiation focus) in a narrow segment. The specific actions required to implement each generic strategy vary widely from industry to industry, as do the feasible generic strategies in a particular industry. While selecting and implementing a generic strategy is far from simple, however, they are the logical routes to competitive advantage that must be probed in any industry.

[5]Without a sustainable competitive advantage, above-average performance is usually a sign of harvesting.

		COMPETITIVE ADVANTAGE	
		Lower Cost	Differentiation
COMPETITIVE SCOPE	Broad Target	1. Cost Leadership	2. Differentiation
	Narrow Target	3A. Cost Focus	3B. Differentiation Focus

Figure 1–3. Three Generic Strategies

The notion underlying the concept of generic strategies is that competitive advantage is at the heart of any strategy, and achieving competitive advantage requires a firm to make a choice—if a firm is to attain a competitive advantage, it must make a choice about the type of competitive advantage it seeks to attain and the scope within which it will attain it. Being "all things to all people" is a recipe for strategic mediocrity and below-average performance, because it often means that a firm has no competitive advantage at all.

Cost Leadership

Cost leadership is perhaps the clearest of the three generic strategies. In it, a firm sets out to become *the* low-cost producer in its industry. The firm has a broad scope and serves many industry segments, and may even operate in related industries—the firm's breadth is often important to its cost advantage. The sources of cost advantage are varied and depend on the structure of the industry. They may include the pursuit of economies of scale, proprietary technology, preferential access to raw materials, and other factors I will describe in detail in Chapter 3. In TV sets, for example, cost leadership requires efficient size picture tube facilities, a low-cost design, automated assembly, and global scale over which to amortize R&D. In security guard services, cost advantage requires extremely low overhead, a plentiful source of low-cost labor, and efficient training procedures because of high turnover. Low-cost producer status involves more than just going down the learning curve. A low-cost producer must find and exploit

all sources of cost advantage. Low-cost producers typically sell a standard, or no-frills, product and place considerable emphasis on reaping scale or absolute cost advantages from all sources.

If a firm can achieve and sustain overall cost leadership, then it will be an above-average performer in its industry provided it can command prices at or near the industry average. At equivalent or lower prices than its rivals, a cost leader's low-cost position translates into higher returns. A cost leader, however, cannot ignore the bases of differentiation. If its product is not perceived as comparable or acceptable by buyers, a cost leader will be forced to discount prices well below competitors' to gain sales. This may nullify the benefits of its favorable cost position. Texas Instruments (in watches) and Northwest Airlines (in air transportation) are two low-cost firms that fell into this trap. Texas Instruments could not overcome its disadvantage in differentiation and exited the watch industry. Northwest Airlines recognized its problem in time, and has instituted efforts to improve marketing, passenger service, and service to travel agents to make its product more comparable to those of its competitors.

A cost leader must achieve *parity* or *proximity* in the bases of differentiation relative to its competitors to be an above-average performer, even though it relies on cost leadership for its competitive advantage. Parity in the bases of differentiation allows a cost leader to translate its cost advantage directly into higher profits than competitors'.[6] Proximity in differentiation means that the price discount necessary to achieve an acceptable market share does not offset a cost leader's cost advantage and hence the cost leader earns above-average returns.

The strategic logic of cost leadership usually requires that a firm be *the* cost leader, not one of several firms vying for this position.[7] Many firms have made serious strategic errors by failing to recognize this. When there is more than one aspiring cost leader, rivalry among them is usually fierce because every point of market share is viewed as crucial. Unless one firm can gain a cost lead and "persuade" others to abandon their strategies, the consequences for profitability

[6]Parity implies either an identical product offering to competitors, or a different combination of product attributes that is equally preferred by buyers.

[7]While the cost leader will be the most profitable, it is not necessary to be the cost leader to sustain above-average returns in commodity industries where there are limited opportunities to build efficient capacity. A firm that is in the lowest quartile of costs though not the cost leader will usually still be an above-average performer. Such a situation exists in the aluminum industry, where the ability to add low-cost capacity is limited by access to low-cost power, bauxite, and infrastructure.

(and long-run industry structure) can be disastrous, as has been the case in a number of petrochemical industries. Thus cost leadership is a strategy particularly dependent on preemption, unless major technological change allows a firm to radically change its cost position.

Differentiation

The second generic strategy is differentiation. In a differentiation strategy, a firm seeks to be unique in its industry along some dimensions that are widely valued by buyers. It selects one or more attributes that many buyers in an industry perceive as important, and uniquely positions itself to meet those needs. It is rewarded for its uniqueness with a premium price.

The means for differentiation are peculiar to each industry. Differentiation can be based on the product itself, the delivery system by which it is sold, the marketing approach, and a broad range of other factors. In construction equipment, for example, Caterpillar Tractor's differentiation is based on product durability, service, spare parts availability, and an excellent dealer network. In cosmetics, differentiation tends to be based more on product image and the positioning of counters in the stores. I will describe how a firm can create sustainable differentiation in Chapter 4.

A firm that can achieve and sustain differentiation will be an above-average performer in its industry if its price premium exceeds the extra costs incurred in being unique. A differentiator, therefore, must always seek ways of differentiating that lead to a price premium greater than the cost of differentiating. A differentiator cannot ignore its cost position, because its premium prices will be nullified by a markedly inferior cost position. A differentiator thus aims at cost *parity* or *proximity* relative to its competitors, by reducing cost in all areas that do not affect differentiation.

The logic of the differentiation strategy requires that a firm choose attributes in which to differentiate itself that are *different* from its rivals'. A firm must truly be unique at something or be perceived as unique if it is to expect a premium price. In contrast to cost leadership, however, there can be more than one successful differentiation strategy in an industry if there are a number of attributes that are widely valued by buyers.

Focus

The third generic strategy is focus. This strategy is quite different from the others because it rests on the choice of a narrow competitive scope within an industry. The focuser selects a segment or group of segments in the industry and tailors its strategy to serving them to the exclusion of others. By optimizing its strategy for the target segments, the focuser seeks to achieve a competitive advantage in its target segments even though it does not possess a competitive advantage overall.

The focus strategy has two variants. In *cost focus* a firm seeks a cost advantage in its target segment, while in *differentiation focus* a firm seeks differentiation in its target segment. Both variants of the focus strategy rest on *differences* between a focuser's target segments and other segments in the industry. The target segments must either have buyers with unusual needs or else the production and delivery system that best serves the target segment must differ from that of other industry segments. Cost focus exploits differences in cost behavior in some segments, while differentiation focus exploits the special needs of buyers in certain segments. Such differences imply that the segments are poorly served by broadly-targeted competitors who serve them at the same time as they serve others. The focuser can thus achieve competitive advantage by dedicating itself to the segments exclusively. Breadth of target is clearly a matter of degree, but the essence of focus is the exploitation of a narrow target's differences from the balance of the industry.[8] Narrow focus in and of itself is not sufficient for above-average performance.

A good example of a focuser who has exploited differences in the production process that best serves different segments is Hammermill Paper. Hammermill has increasingly been moving toward relatively low-volume, high-quality specialty papers, where the larger paper companies with higher volume machines face a stiff cost penalty for short production runs. Hammermill's equipment is more suited to shorter runs with frequent setups.

A focuser takes advantage of suboptimization in either direction by broadly-targeted competitors. Competitors may be *underperforming*

[8]Overall differentiation and differentiation focus are perhaps the most often confused strategies in practice. The difference is that the overall differentiator bases its strategy on widely valued attributes (e.g., IBM in computers), while the differentiation focuser looks for segments with special needs and meets them better (e.g., Cray Research in computers).

in meeting the needs of a particular segment, which opens the possibility for differentiation focus. Broadly-targeted competitors may also be *overperforming* in meeting the needs of a segment, which means that they are bearing higher than necessary cost in serving it. An opportunity for cost focus may be present in just meeting the needs of such a segment and no more.

If a focuser's target segment is not different from other segments, then the focus strategy will not succeed. In soft drinks, for example, Royal Crown has focused on cola drinks, while Coca-Cola and Pepsi have broad product lines with many flavored drinks. Royal Crown's segment, however, can be well served by Coke and Pepsi at the same time they are serving other segments. Hence Coke and Pepsi enjoy competitive advantages over Royal Crown in the cola segment due to the economies of having a broader line.[9]

If a firm can achieve sustainable cost leadership (cost focus) or differentiation (differentiation focus) in its segment and the segment is structurally attractive, then the focuser will be an above-average performer in its industry. Segment structural attractiveness is a necessary condition because some segments in an industry are much less profitable than others. There is often room for several sustainable focus strategies in an industry, provided that focusers choose different target segments. Most industries have a variety of segments, and each one that involves a different buyer need or a different optimal production or delivery system is a candidate for a focus strategy. How to define segments and choose a sustainable focus strategy is described in detail in Chapter 7.

Stuck in the Middle

A firm that engages in each generic strategy but fails to achieve any of them is "stuck in the middle." It possesses no competitive advantage. This strategic position is usually a recipe for below-average performance. A firm that is stuck in the middle will compete at a disadvantage because the cost leader, differentiators, or focusers will be better positioned to compete in any segment. If a firm that is stuck in the middle is lucky enough to discover a profitable product or buyer, competitors with a sustainable competitive advantage will quickly eliminate the spoils. In most industries, quite a few competitors are stuck in the middle.

[9]This example is discussed in more detail in Chapter 7.

A firm that is stuck in the middle will earn attractive profits only if the structure of its industry is highly favorable, or if the firm is fortunate enough to have competitors that are also stuck in the middle Usually, however, such a firm will be much less profitable than rivals achieving one of the generic strategies. Industry maturity tends to widen the performance differences between firms with a generic strategy and those that are stuck in the middle, because it exposes ill-conceived strategies that have been carried along by rapid growth.

Becoming stuck in the middle is often a manifestation of a firm's unwillingness to make *choices* about how to compete. It tries for competitive advantage through every means and achieves none, because achieving different types of competitive advantage usually requires inconsistent actions. Becoming stuck in the middle also afflicts successful firms, who compromise their generic strategy for the sake of growth or prestige. A classic example is Laker Airways, which began with a clear cost focus strategy based on no-frills operation in the North Atlantic market, aimed at a particular segment of the traveling public that was extremely price-sensitive. Over time, however, Laker began adding frills, new services, and new routes. It blurred its image, and suboptimized its service and delivery system. The consequences were disastrous, and Laker eventually went bankrupt.

The temptation to blur a generic strategy, and therefore become stuck in the middle, is particularly great for a focuser once it has dominated its target segments. Focus involves deliberately limiting potential sales volume. Success can lead a focuser to lose sight of the reasons for its success and compromise its focus strategy for growth's sake. Rather than compromise its generic strategy, a firm is usually better off finding new industries in which to grow where it can use its generic strategy again or exploit interrelationships.

Pursuit of More Than One Generic Strategy

Each generic strategy is a fundamentally different approach to creating and sustaining a competitive advantage, combining the type of competitive advantage a firm seeks and the scope of its strategic target. Usually a firm must make a choice among them, or it will become stuck in the middle. The benefits of optimizing the firm's strategy for a particular target segment (focus) cannot be gained if a firm is simultaneously serving a broad range of segments (cost leadership or differentiation). Sometimes a firm may be able to create two largely separate business units within the same corporate entity, each

with a different generic strategy. A good example is the British hotel firm Trusthouse Forte, which operates five separate hotel chains each targeted at a different segment. However, unless a firm strictly separates the units pursuing different generic strategies, it may compromise the ability of any of them to achieve its competitive advantage. A suboptimized approach to competing, made likely by the spillover among units of corporate policies and culture, will lead to becoming stuck in the middle.

Achieving cost leadership and differentiation are also usually inconsistent, because differentiation is usually costly. To be unique and command a price premium, a differentiator deliberately elevates costs, as Caterpillar has done in construction equipment. Conversely, cost leadership often requires a firm to forego some differentiation by standardizing its product, reducing marketing overhead, and the like.

Reducing cost does not always involve a sacrifice in differentiation. Many firms have discovered ways to reduce cost not only without hurting their differentiation but while actually raising it, by using practices that are both more efficient and effective or employing a different technology. Sometimes dramatic cost savings can be achieved with no impact on differentiation at all if a firm has not concentrated on cost reduction previously. However, cost reduction is not the same as achieving a cost advantage. When faced with capable competitors also striving for cost leadership, a firm will ultimately reach the point where further cost reduction requires a sacrifice in differentiation. It is at this point that the generic strategies become inconsistent and a firm must make a choice.

If a firm can achieve cost leadership and differentiation simultaneously, the rewards are great because the benefits are additive—differentiation leads to premium prices at the same time that cost leadership implies lower costs. An example of a firm that has achieved both a cost advantage and differentiation in its segments is Crown Cork and Seal in the metal container industry. Crown has targeted the so-called "hard to hold" uses of cans in the beer, soft drink, and aerosol industries. It manufactures only steel cans rather than both steel and aluminum. In its target segments, Crown has differentiated itself based on service, technological assistance, and offering a full line of steel cans, crowns, and canning machinery. Differentiation of this type would be much more difficult to achieve in other industry segments which have different needs. At the same time, Crown has dedicated its facilities to producing only the types of cans demanded by buyers in its chosen segments and has aggressively invested in modern two-piece

steel canning technology. As a result, Crown has probably also achieved low-cost producer status in its segments.

There are three conditions under which a firm can simultaneously achieve both cost leadership and differentiation:

Competitors are stuck in the middle. Where competitors are stuck in the middle, none is well enough positioned to force a firm to the point where cost and differentiation become inconsistent. This was the case with Crown Cork. Its major competitors were not investing in low-cost steel can production technology, so Crown achieved cost leadership without having to sacrifice differentiation in the process. Were its competitors pursuing an aggressive cost leadership strategy, however, an attempt by Crown to be both low-cost and differentiated might have doomed it to becoming stuck in the middle. Cost reduction opportunities that did not sacrifice differentiation would have already been adopted by Crown's competitors.

While stuck-in-the-middle competitors can allow a firm to achieve both differentiation and low cost, this state of affairs is often temporary. Eventually a competitor will choose a generic strategy and begin to implement it well, exposing the tradeoffs between cost and differentiation. Thus a firm must choose the type of competitive advantage it intends to preserve in the long run. The danger in facing weak competitors is that a firm will begin to compromise its cost position or differentiation to achieve both and leave itself vulnerable to the emergence of a capable competitor.

Cost is strongly affected by share or interrelationships. Cost leadership and differentiation may also be achieved simultaneously where cost position is heavily determined by market share, rather than by product design, level of technology, service provided, or other factors. If one firm can open up a big market share advantage, the cost advantages of share in some activities allow the firm to incur added costs elsewhere and still maintain net cost leadership, or share reduces the cost of differentiating relative to competitors (see Chapter 4). In a related situation, cost leadership and differentiation can be achieved at the same time when there are important interrelationships between industries that one competitor can exploit and others cannot (see Chapter 9). Unmatched interrelationships can lower the cost of differentiation or offset the higher cost of differentiation. Nonetheless, simultaneous pursuit of cost leadership and differentiation is always vulnerable to capable competitors who make a choice and invest aggressively to implement it, matching the share or interrelationship.

A firm pioneers a major innovation. Introducing a significant technological innovation can allow a firm to lower cost and enhance differentiation at the same time, and perhaps achieve both strategies. Introducing new automated manufacturing technologies can have this effect, as can the introduction of new information system technology to manage logistics or design products on the computer. Innovative new practices unconnected to technology can also have this effect. Forging cooperative relations with suppliers can lower input costs and improve input quality, for example, as described in Chapter 3.

The ability to be both low cost and differentiated is a function of being the *only* firm with the new innovation, however. Once competitors also introduce the innovation, the firm is again in the position of having to make a tradeoff. Will its information system be designed to emphasize cost or differentiation, for example, compared to the competitor's information system? The pioneer may be at a disadvantage if, in the pursuit of both low cost and differentiation, its innovation has not recognized the possibility of imitation. It may then be neither low cost nor differentiated once the innovation is matched by competitors who pick one generic strategy.

A firm should always aggressively pursue all cost reduction opportunities that do not sacrifice differentiation. A firm should also pursue all differentiation opportunities that are not costly. Beyond this point, however, a firm should be prepared to choose what its ultimate competitive advantage will be and resolve the tradeoffs accordingly.

Sustainability

A generic strategy does not lead to above-average performance unless it is sustainable vis-à-vis competitors, though actions that improve industry structure may improve industrywide profitability even if they are imitated. The sustainability of the three generic strategies demands that a firm's competitive advantage resists erosion by competitor behavior or industry evolution. Each generic strategy involves different risks which are shown in Table 1–1.

The sustainability of a generic strategy requires that a firm possess some barriers that make imitation of the strategy difficult. Since barriers to imitation are never insurmountable, however, it is usually necessary for a firm to offer a moving target to its competitors by investing in order to continually improve its position. Each generic strategy is also a potential threat to the others—as Table 1–1 shows, for example,

TABLE 1–1 Risks of the Generic Strategies

RISKS OF COST LEADERSHIP	RISKS OF DIFFERENTIATION	RISKS OF FOCUS
Cost leadership is not sustained • competitors imitate • technology changes • other bases for cost leadership erode	Differentiation is not sustained • competitors imitate • bases for differentiation become less important to buyers	The focus strategy is imitated The target segment becomes structurally unattractive • structure erodes • demand disappears
Proximity in differentiation is lost	Cost proximity is lost	Broadly-targeted competitors overwhelm the segment • the segment's differences from other segments narrow • the advantages of a broad line increase
Cost focusers achieve even lower cost in segments	Differentiation focusers achieve even greater differentiation in segments	New focusers sub-segment the industry

The factors that lead to sustainability of each of the generic strategies will be discussed extensively in Chapters 3, 4, and 7.

Table 1–1 can be used to analyze how to attack a competitor that employs any of the generic strategies. A firm pursuing overall differentiation, for example, can be attacked by firms who open up a large cost gap, narrow the extent of differentiation, shift the differentiation desired by buyers to other dimensions, or focus. Each generic strategy is vulnerable to different types of attacks, as discussed in more detail in Chapter 15.

In some industries, industry structure or the strategies of competitors eliminate the possibility of achieving one or more of the generic strategies. Occasionally no feasible way for one firm to gain a significant cost advantage exists, for example, because several firms are equally placed with respect to scale economies, access to raw materials, or other cost drivers. Similarly, an industry with few segments or only minor differences among segments, such as low-density polyethylene, may offer few opportunities for focus. Thus the mix of generic strategies will vary from industry to industry.

In many industries, however, the three generic strategies can profitably coexist as long as firms pursue different ones or select different bases for differentiation or focus. Industries in which several strong firms are pursuing differentiation strategies based on different sources

of buyer value are often particulary profitable. This tends to improve industry structure and lead to stable industry competition. If two or more firms choose to pursue the same generic strategy on the same basis, however, the result can be a protracted and unprofitable battle. The worst situation is where several firms are vying for overall cost leadership. The past and present choice of generic strategies by competitors, then, has an impact on the choices available to a firm and the cost of changing its position.

The concept of generic strategies is based on the premise that there are a number of ways in which competitive advantage can be achieved, depending on industry structure. If all firms in an industry followed the principles of competitive strategy, each would pick different bases for competitive advantage. While not all would succeed, the generic strategies provide alternate routes to superior performance. Some strategic planning concepts have been narrowly based on only one route to competitive advantage, most notably cost. Such concepts not only fail to explain the success of many firms, but they can also lead all firms in an industry to pursue the same type of competitive advantage in the same way—with predictably disastrous results.

Generic Strategies and Industry Evolution

Changes in industry structure can affect the bases on which generic strategies are built and thus alter the balance among them. For example, the advent of electronic controls and new image developing systems has greatly eroded the importance of service as a basis for differentiation in copiers. Structural change creates many of the risks shown in Table 1–1.[10]

Structural change can shift the relative balance among the generic strategies in an industry, since it can alter the sustainability of a generic strategy or the size of the competitive advantage that results from it. The automobile industry provides a good example. Early in its history, leading automobile firms followed differentiation strategies in the production of expensive touring cars. Technological and market changes created the potential for Henry Ford to change the rules of competition by adopting a classic overall cost leadership strategy, based on low-cost production of a standard model sold at low prices. Ford rapidly dominated the industry worldwide. By the late 1920s, however, economic growth, growing familiarity with the automobile, and technological change had created the potential for General Motors to change the rules once more—it employed a differentiation strategy based on a wide line, features, and premium prices. Throughout this evolution, focused competitors also continued to succeed.

[10]*Competitive Strategy,* Chapter 8, describes the processes that drive industry structural

Another long-term battle among generic strategies has occurred in general merchandising. K Mart and other discounters entered with cost leadership strategies against Sears and conventional department stores, featuring low overhead and nationally branded merchandise. K Mart, however, now faces competition from more differentiated discounters who sell fashion-oriented merchandise, such as Wal-Mart. At the same time, focused discounters have entered and are selling such products as sporting goods (Herman's), health and beauty aids (CVS), and books (Barnes and Noble). Catalog showrooms have also focused on appliances and jewelry, employing low-cost strategies in those segments. Thus the bases for K Mart's competitive advantage have been compromised and it is having difficulty outperforming the industry average.

Another more recent example of the jockeying among generic strategies has occurred in vodka. Smirnoff has long been the differentiated producer in the industry, based on early positioning as a high-class brand and heavy supporting advertising. As growth has slowed and the industry has become more competitive, however, private label vodkas and low price brands are undermining Smirnoff's position. At the same time, PepsiCo's Stolichnaya vodka has established an even more differentiated position than Smirnoff through focus. Smirnoff is caught in a squeeze that is threatening its long-standing superior performance. In response, it has introduced several new brands, including a premium brand positioned against Stolichnaya.

Generic Strategies and Organizational Structure

Each generic strategy implies different skills and requirements for success, which commonly translate into differences in organizational structure and culture. Cost leadership usually implies tight control systems, overhead minimization, pursuit of scale economies, and dedication to the learning curve; these could be counterproductive for a firm attempting to differentiate itself through a constant stream of creative new products.[11]

[11]A more detailed review of the differing skills required by each generic strategy is given in *Competitive Strategy*, Chapter 2, pp. 40–41

The organizational differences commonly implied by each generic strategy carry a number of implications. Just as there are often economic inconsistencies in achieving more than one generic strategy, a firm does not want its organizational structure to be suboptimal because it combines inconsistent practices. It has become fashionable to tie executive selection and motivation to the "mission" of a business unit, usually expressed in terms of building, holding, or harvesting market share. It is equally—if not more—important to match executive selection and motivation to the generic strategy being followed.

The concept of generic strategies also has implications for the role of culture in competitive success. Culture, that difficult to define set of norms and attitudes that help shape an organization, has come to be viewed as an important element of a successful firm. However, different cultures are implied by different generic strategies. Differentiation may be facilitated by a culture encouraging innovation, individuality, and risk-taking (Hewlett-Packard), while cost leadership may be facilitated by frugality, discipline, and attention to detail (Emerson Electric). Culture can powerfully reinforce the competitive advantage a generic strategy seeks to achieve, if the culture is an appropriate one. There is no such thing as a good or bad culture per se. Culture is a means of achieving competitive advantage, not an end in itself.

The link between generic strategy and organization also has implications for the diversified firm. There is a tendency for diversified firms to pursue the same generic strategy in many of their business units, because skills and confidence are developed for pursuing a particular approach to competitive advantage. Moreover, senior management often gains experience in overseeing a particular type of strategy. Emerson Electric is well known for its pursuit of cost leadership in many of its business units, for example, as is H. J. Heinz.

Competing with the same generic strategy in many business units is one way in which a diversified firm can add value to those units, a subject I will discuss in Chapter 9 when I examine interrelationships among business units. However, employing a common generic strategy entails some risks that should be highlighted. One obvious risk is that a diversified firm will impose a particular generic strategy on a business unit whose industry (or initial position) will not support it. Another, more subtle risk is that a business unit will be misunderstood because of circumstances in its industry that are *not* consistent with the prevailing generic strategy. Worse yet, such business units may have their strategies undermined by senior management. Since each generic strategy often implies a different pattern of investments and different types of executives and cultures, there is a risk that a business unit that is "odd man out" will be forced to live with inappropriate corporate policies and targets. For example, an across-the-board cost reduction goal or firmwide personnel policies can be disadvantageous to a business unit attempting to differentiate itself on quality and service, just as policies toward overhead appropriate for differentiation can undermine a business unit attempting to be the low-cost producer.

Generic Strategies and the Strategic Planning Process

Given the pivotal role of competitive advantage in superior performance, the centerpiece of a firm's strategic plan should be its generic strategy. The generic strategy specifies the fundamental approach to competitive advantage a firm is pursuing, and provides the context for the actions to be taken in each functional area. In practice, however, many strategic plans are lists of action steps without a clear articulation of what competitive advantage the firm has or seeks to achieve and how. Such plans are likely to have overlooked the fundamental purpose of competitive strategy in the process of going through the mechanics of planning. Similarly, many plans are built on projections of future prices and costs that are almost invariably wrong, rather than on a fundamental understanding of industry structure and competitive advantage that will determine profitability no matter what the actual prices and costs turn out to be.

As part of their strategic planning processes, many diversified firms categorize business units by using a system such as build, hold, or harvest. These categorizations are often used to describe or summarize the strategy of business units. While such categorizations may be useful in thinking about resource allocation in a diversified firm, it is very misleading to mistake them for strategies. A business unit's strategy is the route to competitive advantage that will determine its performance. Build, hold, and harvest are the results of a generic strategy, or recognition of the inability to achieve any generic strategy and hence of the need to harvest. Similarly, acquisition and vertical integration are not strategies but means of achieving them.

Another common practice in strategic planning is to use market share to describe a business unit's competitive position. Some firms go so far as to set the goal that all their business units should be leaders (number one or number two) in their industries. This approach to strategy is as dangerous as it is deceptively clear. While market

share is certainly relevant to competitive position (due to scale economies, for example), industry leadership is *not a cause but an effect of competitive advantage.* Market share per se is not important competitively; competitive advantage is. The strategic mandate to business units should be to achieve competitive advantage. Pursuit of leadership for its own sake may guarantee that a firm never achieves a competitive advantage or that it loses the one it has. A goal of leadership per se also embroils managers in endless debates over how an industry should be defined to calculate shares, obscuring once more the search for competitive advantage that is the heart of strategy.

In some industries, market leaders do not enjoy the best performance because industry structure does not reward leadership. A recent example is Continental Illinois Bank, which adopted the explicit goal of market leadership in wholesale lending. It succeeded in achieving this goal, but leadership did not translate into competitive advantage. Instead, the drive for leadership led to making loans that other banks would not, and to escalating costs. Leadership also meant that Continental Illinois had to deal with large corporations that are extremely powerful and price-sensitive buyers of loans. Continental Illinois will be paying the price of leadership for some years. In many other firms, such as Burlington Industries in fabrics and Texas Instruments in electronics, the pursuit of leadership for its own sake seems to have sometimes diverted attention from achieving and maintaining competitive advantage.

Overview of This Book

Competitive Advantage describes the way a firm can choose and implement a generic strategy to achieve and sustain competitive advantage. It addresses the interplay between the types of competitive advantage—cost and differentiation—and the scope of a firm's activities. The basic tool for diagnosing competitive advantage and finding ways to enhance it is the *value chain,* which divides a firm into the discrete activities it performs in designing, producing, marketing, and distributing its product. The scope of a firm's activities, which I term *competitive scope,* can have a powerful role in competitive advantage through its influence on the value chain. I describe how narrow scope (focus) can create competitive advantage through tailoring the value chain, and how broader scope can enhance competitive advantage through the exploitation of interrelationships among the value chains that serve

different segments, industries or geographic areas. While this book addresses competitive advantage, it also sharpens the ability of the practitioner to analyze industries and competitors and hence supplements my earlier book.

This book is organized into four parts. Part I describes the types of competitive advantage and how a firm can achieve them. Part II discusses competitive scope within an industry and its affect on competitive advantage. Part III addresses competitive scope in related industries, or how corporate strategy can contribute to the competitive advantage of business units. Part IV develops overall implications for competitive strategy, including ways of coping with uncertainty and to improve or defend position.

Chapter 2 presents the concept of the value chain, and shows how it can be used as the fundamental tool in diagnosing competitive advantage. The chapter describes how to disaggregate the firm into the activities that underlie competitive advantage, and identify the linkages among activities that are central to competitive advantage. It also shows the role of competitive scope in affecting the value chain, and how coalitions with other firms can substitute for performing activities in the chain internally. The chapter also briefly considers the use of the value chain in designing organizational structure.

Chapter 3 describes how a firm can gain a sustainable cost advantage. It shows how to use the value chain to understand the behavior of costs and the implications for strategy. Understanding cost behavior is necessary not only for improving a firm's relative cost position but also for exposing the cost of differentiation.

Chapter 4 describes how a firm can differentiate itself from its competitors. The value chain provides a way to identify a firm's sources of differentiation, and the fundamental factors that drive it. The buyer's value chain is the key to understanding the underlying basis of differentiation—creating value for the buyer through lowering the buyer's cost or improving buyer performance. Differentiation results from both actual uniqueness in creating buyer value and from the ability to signal that value so that buyers perceive it.

Chapter 5 explores the relationship between technology and competitive advantage. Technology is pervasive in the value chain and plays a powerful role in determining competitive advantage, in both cost and differentiation. The chapter shows how technological change can influence competitive advantage as well as industry structure. It also describes the variables that shape the path of technological change in an industry. The chapter then describes how a firm can choose a

Sabre Gives The Edge To American Airlines

AA reservation system carves out huge profits and new markets

WHARTON REPROGRAPHICS 4

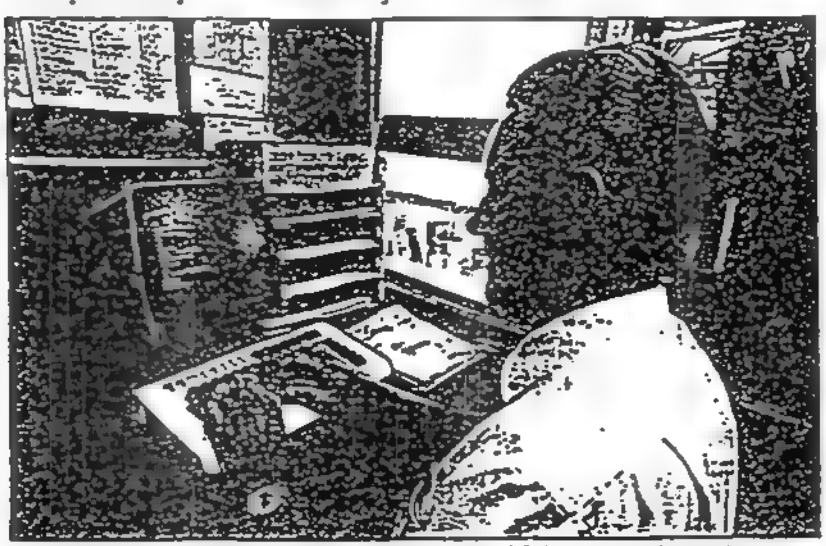
Back in the 1960s, American Airlines Inc. developed a rudimentary computerized reservation system called the Semi Automated Business Research Environment, or Sabre. Today, Sabre is the world's largest travel agency reservation system. It is also a prime example of how a corporation has used information technology to generate new sources of revenue and, in the process, to outperform its competition.

American began installing Sabre 10 years ago in travel agencies throughout the country. The system is now piped to 11,000 travel agencies—nearly half of those that are automated in the United States. Every day, they book about 500,000 airline, hotel, and rental-car reservations on Sabre.

But the system has done more than generate new revenue. By increasing the business American gets from travel agents, Sabre has helped the company withstand the competition from low-cost carriers and the profit-robbing fare wars they have fomented since deregulation of the industry began in 1978. Some of its competitors have charged—in lawsuits and in congressional investigations into the use of computerized reservation systems—that one reason American's business increased was that Sabre displayed American's flights more prominently than those of any other airline on the booking agents' CRT screens. In 1984, the Civil Aeronautics Board, after a request from Congress to look into the issue, ordered the removal of such screen bias. But other allegations against American continue. Eleven other airlines, including Continental Airlines Corp., have filed an antitrust suit against American and United Air Lines Inc. over the use of their reservation systems. The parties are awaiting a trial date. And last spring, a Senate subcommittee decided to drop a planned investigation into whether the airline sponsors of travel-agency systems should divest themselves of the operations.

The antitrust action, if successful, could force American to shed itself of Sabre. But for the time being, the system continues to make money for the company. Last year, though Sabre accounted for only 5% of the overall revenue of AMR Corp., American's parent company, it brought in one-sixth of its total operating profit.

Sabre emerged, 10 years ago, through the foresight of Robert Crandall and Max Hopper. Crandall then was an American Airlines marketing executive; he is now the airline's chairman and chief executive. Hopper was a data processing manager. (He left the airline in 1982 to run Bank of America's DP operation, but returned last year as American's senior vice president of information systems.)


11,000 travel agencies currently use American Airlines' Sabre reservation system

Back in the early 1970s, as Hopper explains it, a group of large travel agencies banded together to plan the construction of a huge national reservation system with the help of an independent computer vendor. A number of airlines, including American and United, decided it might not be in their best interests to let that happen.

American got together with other airlines and with an association of travel agents to propose to the Civil Aeronautics Board an airline-industry-sponsored study of a travel-agency system. The team effort, however, didn't last long. Early in 1976, United quit, announcing it would develop its own travel-agency system (see story, page 55). One day after the United announcement, American pulled out of the group and said it, too, would provide its own system. The race was on.

American won. "We stretched people way beyond how anybody likes to stretch people," Hopper recalls, adding that several airline system projects at American had to be postponed. "Our people recognized that we were in a battle that had to be won very quickly, or the opportunity was never going to be there again."

American started shipping Sabre to travel agencies in April of 1976. "We used the study we were all privy to to define the needs of the marketplace. We tried to build a product to serve it, rather than taking an existing product and saying, 'Use this.'" Hopper says.

Few competing airlines were willing to take the chance American took: Its $350 million investment did not be-

STRATEGIC SYSTEMS

come profitable until 1983. Rather than compete with Sabre, in fact, a number of other airlines have decided to use it themselves. Pan Am recently decided to abandon its system, Panamac, in favor of buying Sabre's services.

Those services continue to expand; new ones are continually being developed. Sabre has, for example, been the original basis for office automation software sold to travel agencies. One such office system, called Agency Data Systems, has been installed in 2,600 locations, for a 46% market share, according to the company.

The new capabilities, and the new services they provide, indicate how far Sabre has come. Originally, travel agencies entered orders using an IBM Selectric typewriter that was enhanced to perform teletype functions. Today, they use terminals or, increasingly, personal computers, hooked on-line to five IBM mainframes. The mainframes—three 3090 Model 200s and two 3083s, with hundreds of 3380 disks backing them up—work in tandem, churning out data held in Sabre's huge data base.

The mainframes are hooked together by a network that handles more than 1,200 transactions a second, during peak times, from 50,000 CRTs. A series of private lines is being phased out in favor of 14 central-switching nodes across the country that will handle private lines in their regions. Four of the nodes are running; the rest will be working within the next 18 months.

About 400 programmers work strictly on Sabre, and Hopper counts another 1,500 staff members that provide technical, product, sales, and service support. The crew is split between American's headquarters in Dallas, where some applications-development programmers work, and Tulsa, where the hardware, communications, and other applications developers reside.

Having returned to American, Hopper faces a number of projects that will improve Sabre. One is to add more outside data bases to the system. Sabre now has 18 on-line, including Amtrak's train schedules and Avis's car-rental system. Twenty-five are expected to be in place by the end of the year.

The biggest challenge for Hopper is making sure that other technologies don't do an end-run around the Sabre system, says Michael Vitale, a professor at the Harvard Business School. Already, consumers can make airline reservations via their personal computers through programs sponsored by the Official Airlines Guide and others.

American, in response, quietly announced, in February, a program called Eaasy Sabre that lets travelers use the system directly. Such a capability should be attractive to consumers, for Sabre does more than book planes, cars, and hotel rooms. Users can reserve theatre tickets, hire limousines, buy insurance, and perform a host of other travel-related functions.

By going directly to consumers, however, American risks alienating the very travel agents that have made Sabre a success. So far, it has placated them by letting corporate users have direct access to Sabre, but getting the travel agent of their choice to issue the tickets. That way, the travel agency keeps its commission.

In any case, American is going to keep looking for ways to get more out of Sabre. It is working now with large office systems vendors—Data General Corp., Wang Laboratories Inc., and Digital Equipment Corp.—to integrate Sabre's data base with the vendors' integrated office software systems. Such efforts offer American the opportunity to diversify without spreading itself too thin. "We've successfully diversified within the travel business," says Crandall. "And we've done it without buying a single hotel or car-rental company." —*Robert Buday*

5

AHSC On-Line System Ships Supplies ASAP

Ordering system is American Hospital's lifeline to customers

American Hospital Supply Corp. (AHSC) has grown from $1 billion in annual revenue a decade ago to $3 billion last year without having to add a significant number of people to its field sales force. Much of the credit goes to a critically important information system, called ASAP, that lets the Evanston, Ill., health-care distributor's hospital customers automate their ordering process. "It's probably been the single most helpful marketing tool that we've had to help the customer," says Karl D. Bays, the company's chairman.

ASAP stands for Analytic Systems Automatic Purchasing, and it was the first system to be used by a hospital-supply company to computerize purchasing by its customers. The system permits more than 4,500 hospitals and other medical facilities to order supplies on-line by tapping a huge data base that keeps track of some 150,000 items that American distributes, from gauze to intravenous fluids.

The system is taking on a much larger role these days, since the company will have many more products to sell. That's because, last year, it was acquired by its Chicago-area competitor, Baxter Travenol Laboratories Inc., and that firm's products will be added to AHSC's line. After considerable discussion and customer surveys to see what systems customers preferred, top executives decided that ASAP should predominate. Baxter customers are [redacted] being converted over to ASAP.

The importance of ASAP would be hard to overstate. About half the nation's 6,000 acute-care hospitals use ASAP now, according to Susan Scott, a senior marketing manager for the system, double the number using it in 1981.

Besides streamlining customers' ordering chores, the system has made American more efficient: Last year 46% of its distribution sales orders came over ASAP, up from 31% in 1981. The company figures the system saves it more than $3 million annually. ASAP not only has automated ordering; it is intertwined with American's inventory, financial, sales reporting, and billing systems, which now are being pushed off Burroughs Corp. mainframes at American's data center in McGaw Park, Ill., in favor of two IBM 3090 mainframes.

The result, from a hospital's standpoint, is that in two minutes or less it knows what items American has in stock, and at what price. When a customer transmits his order over ASAP, copies of the confirmed order are sent back to the customer and to one of American's 66 distribution centers. From there, the order is filled and then trucked to the customer, who is guaranteed 95% product availability

within 24 hours, according to Mike Heschel, corporate vice president of information services. Sounds simple, but ASAP processes about 50,000 such orders daily; invoices from the orders are prepared nightly.

As important as ASAP has been to American, the company admits that it basically stumbled on to the idea. In the early 1960s, the Stanford Medical Center in California frequently was getting orders from American that were incomplete and late. In response, American's West Coast sales office installed an IBM 1001 data phone in the hospital's purchasing department and gave the manager prepunched cards that corresponded to supplies to be reordered. At the other end of the phone line, in American's distribution center, was an IBM 026 card-punch machine. Each card run through the 1001 caused a duplicate card to be punched by the 026.

It wasn't long before 200 other customers had the system, which the company then called Tel-American. As punch cards became obsolete, American eventually moved to a system based on Bell 43 terminals installed at customer-hospitals and connected to mainframes at American. Customers paid for the terminals. American picked up the often-steep phone charges.

ASAP has since been enhanced so more devices could be hooked up to it. Today, ASAP can accommodate input devices ranging from bar-code scanners to dumb terminals to microcomputers, minicomputers, and mainframes.

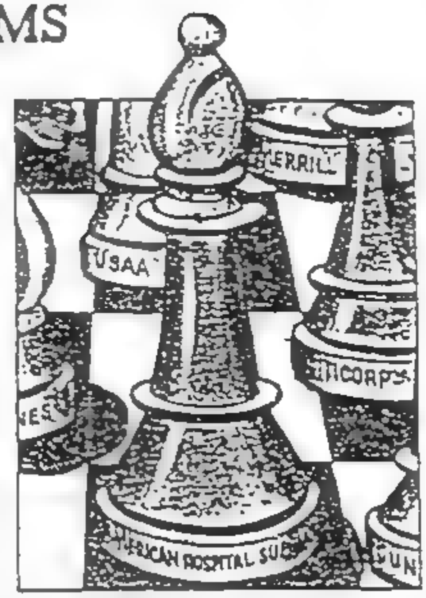
At the same time, the information flow between customer and distributor has increased. The first update of ASAP provided for product verification, stock status, and price. It also allowed messages to be transmitted from customers to the corporation.

By 1980, customers could use their own internal stock numbers when ordering, rather than AHSC's catalog numbers. Hospitals also could build electronic files for orders they would make again and again. They could get on-line status on back orders, prices, and delivery times. In 1983, ASAP could take orders directly from customer information systems. Links to IBM's Personal Computer came at the end of 1984.

Competitors haven't been standing still. For example, one big rival, Johnson & Johnson, has come out with an ordering system called CO-ACT that it claims can do many of the things American's does.

That will put more pressure on American's information services department, which runs ASAP, to keep the system competitive. The department is staffed with 12 programmers and six full-time people who provide support over hot lines. MIS, line managers, and customers meet quarterly to plot ASAP strategy and plan the latest enhancement of the system.

Nine corporate systems managers sell the system to new customers, a change from the past when any American salesperson could sign up



new ASAP users. "When we got into linking computers together and the microcomputer world, we found we needed some people who were specifically trained to work with customers," Scott says.

What American needs to do now is integrate ASAP tightly with its other corporate systems, says Michael Vitale, a Harvard Business School professor who did a case study on ASAP in 1985. "The real prowess of ASAP is in the integration of other systems of American," he says. By contrast, some competing companies have order-entry systems that are easier to use but are not tied into their inventory systems. The system will record the order faithfully, but the item being ordered might not be in stock.

At the moment, American is trying to push ASAP further into its customer sites. American claims it is the first health-care company with a pilot project that does electronic invoicing and funds transfer from customer accounts. The system has met with some resistance: In many hospitals, purchasing and finance are separate departments that don't work hand-in-hand.

Even so, American's competitors will be hard-pressed to come up with something as powerful as ASAP, and they know it. Baxter officials, in fact, tried to estimate how much it would cost to beat American instead of merge with it. They said, before the merger, that they would probably have to spend $50 million to develop a system that competes with ASAP. At those prices, it's going to be a while before anybody comes up with anything better. —*Robert Buday*

About half the nation's 6,000 acute-care hospitals use the ASAP purchasing system

6

WHARTON REPROGRAPHICS

Guidelines for Case Analysis

The objectives of the case method are to provide training in systematic, analytical thinking creative problem-solving and decision-making. Although there are a number of ways to approach a case problem, the key focus should be accomplishing the objectives and answering the relevant questions as defined by your professor. The following steps outline an orderly approach to case analysis to help you get maximum benefit from the time you spend preparing and discussing a case.

Preparing the Case

1. Read through the entire case quickly to get a general idea of the case situation. This enables you to begin thinking about the case while you are doing other things (like brushing your teeth, playing frisbee); flashes of creative brillance occur at odd times. Read the case a second time, slowly, and possibly a third time taking notes. Jot down ideas, questions, and note places where the case reminds you of theories or issues you have considered in class.

2. Summarize the key facts of the case briefly. In many cases, you will wish that you had more information. In other cases, you have too much information, and must screen the facts, eliminating irrelevant information. It may be necessary to make some assumptions as the case analysis progresses, but these should be realistic ones (in other words don't "assume away" the problem!). In general, assumptions should be minimized and you should clearly state the bases for your assumption.

3. Analyze the facts. Consider the environment within which the situation is taking place. Ask yourself what factors and people are affecting the situation and how? What are the objectives of the organization and the individuals involved? Objectives may not always be stated, but realistic and logical ones can usually be defined. A careful consideration of the facts will reveal the problem, will suggest many possible alternative actions and will largely dictate what courses of action are feasible. In your analysis, you should bring in concepts and ideas from the course you are studying. Think about how course theories and concepts might apply to the case situation.

4. Identify the problem(s) or key issue(s). Often the problem is readily apparent, but not always. There may be more than one problem, and the problems may not be of equal importance. In defining the problem, it is important to state the problem clearly.

   A problem is the source of a dilemma in a case. It is easy to mistake symptoms for problems. You should be addressing the cause of a deficiency, not a signal or symptom of the cause. For example, a firm is experiencing high turnover. What is the problem? It is not a problem with high turnover—this is a symptom of a problem that is causing high turnover—this is a symptom of a problem that is causing high turnover. Hiring the wrong people? But what is causing the selection process to yield the wrong people? Keep going until you think you have the cause of the deficiency.

   Some cases do not have problems as such; they have central issues or a decision to be made. Don't make up problems where none exist. This may lead to undue demolition when a remodeling job would have sufficed and would have been more in tune with the real world.

   Write a short, concise problem statement or description of the central issue(s). Provide supporting information.

   Caution: Beware of labeling something a communication problem between two or more people. At some level, almost all problems have a communication element. A communication problem is almost always a symptom. Ask yourself what the "communication problem" is about, what has caused it to occur?

USEFUL REFERENCE — B. WEBER

5. Develop alternative courses of action. Think of all possible courses of action which will solve the problem as defined, or which are related to the central issues in the case. This step will require knowledge and application of course material as well as creativity. The alternatives must be realistic in light of the facts of the case and the results of your analysis so far.

6. Consider and evaluate alternative courses of action. Bearing in mind the facts of the case, consider each alternative in light of the problem, the objectives, and its projected future effects.. How will each alternative solve the problem and what potential new problems might it create? List the advantages and disadvantages of each alternative, considering how each one will affect other people and systems in the organization. Although you can't predict the future precisely, you can draw certain justified conclusions about the results of a particular course of action.

   Eliminate the alternatives that do not solve the problem. You may not wish to, or may not have room to, discuss all of your alternatives in a written or oral presentation but you should discuss more than one alternative. This highlights your rationale and will help you to show why your chosen alternative will be effective.

7. Select the best alternative(s) and substantiate them in the form of recommendations. In substantiating your recommendations, you should rely on facts of the case and course material. Your recommendations should be justified by case facts or material you have considered in class and should contribute to reaching objectives and must resolve the problem(s) as you have defined them. The single most troublesome aspect of case analysis for many students (and managers) is that they are not able to make clear why or how their recommendations relate back to the problem defined.

   Final Note: Throughout your analysis, you should apply course concepts, theories and terminology wherever possible and appropriate. Your purpose is to show that you have learned course material and can bring it to bear to solve managerial problems. Therefore, if the class is a class in human resource management or organizational behavior, your analysis should not rehash what you learned in marketing class. Many cases are complex and involve a number of interrelated functional areas. Marketing issues may indeed be part of the problem, and you may wish to note them. You can safely assume (trust me) that your professor would not have assigned the case if it were devoid of issues that directly reflect course-related material so that is the viewpoint to emphasize.

Participating in Case Discussions

1. Keep in mind that there is usually more than one right answer. A case is a problem-solving situation, and managerial effectiveness often depends upon seeing different solutions. (Remember Plan B.)

2. Offer your ideas, substantiating them with facts from the case and course material.

3. Adopt an open-minded stance, entertain new ideas from others and consider how your recommendations might change in ligth of these new insights.

4. Be fearless, but professional and most important, respectful in questioning or disagreeing with a colleague. Case discussions are also an opportunity to refine interpersonal skills. "I see some drawbacks to your proposal" or "I'm wondering if you considered the effects of x on y" creates a much different climate than "You're wrong" or "That's not a good idea."

5. Write down new ideas that occur to you and make note of any theories or course concepts brought to bear that you did not apply in you analysis.

6. Evaluate the discussion and your participation in it. What could you do to improve in the next case discussion?

7. Enjoy yourself! Cases are fun and are an exciting way to learn.

Capital One:

Exploiting an Information-Based Strategy in Newly Vulnerable Markets

Eric K. Clemons
Matt E. Thatcher

Version 4.2
27 August 1997

1. Introduction

After soliciting 16 banks in 1988 as consulting clients for a radical transformation of their credit card businesses and after having been turned down by each, Rich Fairbank and Nigel Morris now enjoy their positions as Chairman / Chief Executive and President / Chief Operating Officer of Capital One, one of the world's most profitable credit card issuers. As a result of its rapid growth and its ability to retain profitable accounts, Capital One was named credit card issuer of the year in 1995 by **Credit Card Management** (Lucas, 1995). Additionally, Rich Fairbank received the Gartner Group's 12th annual Excellence in Technology award for Capital One's success under his leadership.

Since 1992, the dollar value of loans managed by Capital One has increased from $1.7 billion to $12.8 billion and the customer base has grown by over 500% (Gartner Group, 1996). With total growth in outstanding balances of 880% between 1992 and 1996, among the highest in the industry[1], and bad loan chargeoffs consistently among the lowest in the industry, the stock's price soared between 1991 and 1996. The opening line in a Donaldson, Lufkin & Jenrette Equity Research newsletter from July 1996 describes Capital One simply as "Still Our Top Pick!" This assessment was repeated in February 1997. Nigel Morris

1 Outstandings, or ***outstanding balances***, represent the amount of money that a credit card issuer is owed by card holders. It is generally considered desirable to have high outstanding balances, since this represents money that cardholders have borrowed from issuers, and on which issuers are generally paid a high annual rate of interest. Of course, issuers must be careful to manage the risk associated with high outstandings and must balance the benefits of higher interest payments resulting from increasing outstandings against the possibilities of losses from increasing exposure to non-payment of these unsecured loans.

smiles when he adds, "Sometimes I pinch myself. I've been very lucky... helping manage this fabulous company. Sometimes I think I'll wake up and find myself working in a woolen mill near my family in Wales."

The lessons of Capital One's success in the banking industry can be extended to a large number of other companies in a wide range of other industries. In this case study we will first examine the sources of Capital One's success, and then generalize them.

We use the term ***newly vulnerable markets*** to describe markets that appear to be mature and stable and that appear to favor large incumbents, while actually exhibiting conditions that provide new entrants with opportunities to achieve positions of dominance. Although these new entrants frequently must contend with a higher cost structure than that of incumbents, they are often able to achieve greater profitability by exploiting new and different strategies. In Section 2 we describe these conditions that characterize these markets and the strategies that enable new entrants to succeed; thereafter, we focus on the strategy that enabled Capital One to exploit these conditions.

In 1988 the credit card industry appeared relatively mature, and competition was based primarily on the acquisition of market share; that is, competition had become primarily a scale play. However, acquiring new accounts was both difficult and expensive, because most credit-worthy adults received more solicitations than they were willing to read and had more cards than they needed or wanted. And yet, it was in this apparently mature, stable, and saturated market that Rich and Nigel launched their new strategic approach to the credit card business.

When Rich and Nigel joined Signet Bank in 1988, the bank had a credit card portfolio of 1 million accounts and approximately $1 billion in outstanding balances. By September 1994, when Signet spun off its credit card business as an independent company (i.e., Capital One), Signet's account base had grown to 4.8 million accounts and $6.7 billion in outstandings. Since the spin-off Capital One

has refined its strategy and thus has continued the patterns of growth established by Signet; at the end of 1996 Capital One's portfolio included 8.6 million accounts and $12.8 billion in outstandings.

The company relies heavily on what it terms its ***Information-Based Strategy*** (IBS). The use of an IBS allows Capital One to develop new and different strategies by exploiting fundamental differences between itself and its competitors in organizational structure, corporate culture, and use of information. Rich and Nigel define an information-based strategy as the use of scientific testing to drive mass customization, enabling them to deliver "the right product to the right customer, at the right time and at the right price."

As its credit card business matures and as competition increases, the company is prepared to diversify into a wide range of industries where it believes that its IBS approach will provide competitive advantage. Indeed, marketing efforts and spending increasingly are committed to ventures outside traditional banking, and the senior officers believe that it is critical that they "not remain loyal to any industry." Their key strengths are in IBS, and not in banking or the credit card industry.

We will seek to address the following questions in this case study:

- Does Capital One enjoy a competitive advantage?
- How was competitive advantage achieved?
- Why were the opportunities identified by Signet / Capital One first exploited by a relative outsider — a small regional bank under the guidance of consultants rather than bankers? Why were these opportunities neither observed nor exploited by the dominant money center banks or the retail banks with the largest market presence?
- Is the advantage sustainable? Can other banks copy the strategy? Will this erode the advantage?

- What are some other applications of Capital One's information-based strategy?

The paper is structured as follows. Section 2 reviews the theory of newly vulnerable markets. Sections 3 provides more data on Capital One and provides an assessment of its ability to achieve competitive advantage. Section 4 describes how Capital One achieved competitive advantage. Section 5 addresses whether Capital One's advantage is sustainable or whether actions taken by competitors will ultimately erode its profitability. Section 6 speculates about future opportunities for the application of their information-based strategy to other industries, either by the team at Capital One or by others. Section 7 provides conclusions.

2. Newly Vulnerable Markets

2.1. Introduction

As noted above, a large number of industries exhibit characteristics that change the relative balance of power between large incumbents and nimble new entrants. We use the term *newly vulnerable markets* to characterize those conditions that enable new entrants to threaten previously dominant incumbents, even where those incumbents enjoy dominant market share and resulting superior cost structures[2].

The following conditions generate vulnerable markets:

- Ease of entry — It must be possible for new entrants to enter the market and attack established firms. Potential barriers to entry, including regulatory restricions and costs associated with acquiring

2 In previous work, we have explored these conditions and their application to a wider range of industries. In this earlier work, we originally termed these vulnerable industries ***Newly Contestable Markets*** but have switched terminology to avoid confusion with the term contestability in economics. [Clemons, Croson, and Weber, 1996].

distribution or production facilities, must be low enough to provide new entrants with the ability to attack.

- Attractive to attack — New entrants must perceive that it will be profitable for them to attack. That is, they must believe that there are market segments where the difference between the costs associated with serving those segments and the prices that they can charge those segments will be sufficient to provide favorable profits, even when adjusted for the risks of attacking existing dominant players with commanding market share advantage.

- Difficult to defend — There must be some obstacles that prevent incumbents from immediately duplicating the strategies of new entrants, and thus that allow new entrants sufficient time to realize the benefits from their entry.

2.2. Differing Customer Costs and Uniform Pricing

In many industries there are enormous differences between the costs of providing service to different customers:

- In telecommunications, costs of providing customers with local service will often depend upon their distance from the central office, and thus the length of the dedicated local loop that connects their home to the communications network

- In health insurance, costs of providing coverage to policy-holders will typically depend upon policy-holders' propensities to develop expensive illnesses that result in large claims. Such propensities differ dramatically across policy-holders and will often depend upon factors such as genetic predisposition, demographic background, and lifestyle choices.

- And in banking, some customers use their credit cards largely as charge cards, paying off their balances in full each month; these customers enjoy the free float, but provide only limited revenues and even smaller profits for their issuers.

And yet, historically, in many industries dominant players have continued to follow a uniform pricing strategy, charging customers prices based upon average costs, rather than differential prices that reflect the costs associated with serving these individual accounts:

- In telecommunications, state regulators largely determine prices and typically over-charge customers in cities and suburbs in order to subsidize higher cost customers in rural communities. The intent of such actions is to provide the state with universal telecommunications service at rates affordable to most consumers.

- In health insurance, regulators increasingly control what information insurance companies can use to price policies. By restricting insurance companies' use of information on genetic disposition and family background, regulators are forcing insurance companies to engage in uniform pricing of policies despite differences in customer riskiness.

- And in banking, most banks have historically not performed customer profitability analyses, and instead have charged all accounts prices that do not reflect their profitability. Indeed, at the time that Rich and Nigel began their assault on established credit card practices, customers at most banks were typically charged the same annual fee and the same annual percentage rate finance charges.

Conditions such as those described above make markets attractive for new entrants to attack, as they suggest that some customers are being dramatically over-charged under average cost pricing strategies, and that they are in fact subsidizing other higher cost customers.

Retail banking provides a clear example of how a new entrant can enter an "attractive" market and acquire profitable market share at the expense of a previously dominant incumbent firm (Clemons and Weber, 1994), (Clemons, Croson, and Weber, 1996). In many industries, firms can distinguish between those customers that account for their profits (i.e., *love 'ems*) and those customers that represent loss making accounts (i.e., *kill yous*). In retail banking, for example, the best 20% of consumers may account for more than 100% of a bank's profits, while the bottom 20% may account for all the off-setting losses.

Most retail banks in 1988 charged uniform prices across consumers for banking services despite the presence of significant differences in customer costs (i.e., love 'em and kill you accounts). This situation provides an opportunity for competitors to target the love 'ems accounts, charging them less for the provision of banking services than they are charged by their current bank but at prices that still generate profits for the attacker. Such targeted marketing and opportunistic cream skimming will leave the incumbent serving a larger proportion of higher cost, kill you accounts and will cause the incumbent's average costs to rise and profits to fall. In response, the incumbent will be tempted to raise its prices to compensate for declining profits, resulting in even more customers becoming vulnerable to the new entrants' attack. As the new entrant continues to target customers being overcharged by the incumbent, as the incumbent continues to raise its prices to compensate for its losses, and as the new entrant continues to acquire profitable market share at the expense of the incumbent, the defender may begin to enter "death spiral" [Clemons and Weber, 1994]. That is, for the defender, "the worse it gets the worse it gets!"

There is a literature and supporting theory on how to perform targeted marketing and to provide differential offerings (e.g., Blattberg and Deighton, 1991) and on why differential pricing is important (e.g., Tirole, 1988). However, there is very little evidence to suggest that this was followed in banking prior to Fairbank's and Morris's implementation of targeted marketing strategies in the credit card business of Signet Bank in the late 1980s.

Competitors' reliance upon uniform pricing in the presence of extreme differences among customers set the stage for Rich and Nigel's information-based strategy, and is no doubt the most important reason for Capital One's success. Rich and Nigel acknowledge this in their letter to stockholder in their annual report for 1995 : "This strategy of mass customization represents a quantum breakthrough in marketing effectiveness and has led to tremendous success competing against traditional banking industry with its one-size-fits all approach to marketing."

3. Capital One and Competitive Advantage

3.1. The Early Days

In the late 1980s, Rich and Nigel developed an idea, or a vision, for radically transforming the credit card businesses within banks. *The Great Idea* was to enable a bank, through a radical transformation of their credit card business, to acquire profitable market share and develop competitive advantage by implementing targeted, information-based marketing strategies (or IBS). At that time, they might have articulated this vision as follows:

- Not all banking customers are equally profitable to serve
- Banks do not know who their most profitable accounts are, so these accounts are vulnerable to competitors who could identify them
- Direct marketing techniques, allowing banks to solicit many consumers at relatively low cost, has turned some banking products, like credit cards, into a national, rather than a local or regional business.
- When using targeted direct marketing, it will be necessary to <u>test</u> different targeted offerings, in order to <u>learn</u> the combination of

characteristics that make different products desirable to customers and profitable for credit card issuers.

- Since most combinations of product offerings may be unprofitable for most customers, it will be necessary to start with small tests, but when learning is complete larger rollouts can be made.

Nigel also stresses that it was not necessary to create a new product or a new brand — that is, improving the profitability of a bank's existing MasterCard or Visa portfolio had far fewer entry barriers than attempting to create a new brand.

Rich and Nigel acquired these insights by observing the credit card businesses of many of their major banking consulting clients at the time. Once the insight was developed, they solicited numerous banks as consulting clients to radically transform the credit card business by exploiting their insights. However, most banks were not interested in what became known as their information-based strategy. In fact, it was not until after the first 16 banks rejected their solicitations that they found a home at Signet Bank.

By 1988, the credit card industry was characterized by competition among banks for scale and market share; as a result, the credit card business had made the transition to consolidation in the hands of large players. By increasing their customer base, banks were able to spread the high fixed costs associated with credit card operations over a large number of accounts, enabling them to lower prices through economies of scale.

In addition, during this period banks commonly engaged in uniform pricing strategies, creating attractive opportunities for attack. In fact, the top ten banks typically charged their customers the same 19.8% annual interest rate, clearly indicating the sort of average cost pricing that creates newly vulnerable markets and enables opportunistic targeting strategies. In addition, the average cost associated with acquiring new accounts in this competitive environment (cost per solicitation divided by hit rate) was quite high. This too suggests that

incumbent banks were vulnerable to an opportunistic marketing strategy that improved hit rates by selectively offering lower annual interest rates to certain potential "love 'em" customers.

As Rich and Nigel note, while competitors in this market appear vulnerable to opportunistic targeting strategies, executing these strategies is not easy. Or, as Nigel Morris has said, "Anyone can find customers who want your money! Anyone can find customers who will take it and not pay you back! The trick is to find customers who will take a lot of your money fast and pay you back slowly."

It was in this competitive environment that Rich and Nigel attempted to pitch *The Great Idea*. Rich and Nigel began to shop their idea to major banks, including New York and West Coast money center banks and super-regionals. Although many of the major banks were willing to work with Rich and Nigel in other areas, their *Great Idea* was rejected by five of the top six (Citibank, Chase, Bank of America, Bank of New York, and Chemical Banking) and fourteen of the top twenty banks in the U.S.. Reactions were remarkably similar across institutions:

- "It can't be done!" — it's too expensive, and the data that you need on individual consumers to make the strategy succeed is simply not available to the bank

- "And we don't need your help; we already do it!"

Finally, Signet Bank, a small bank looking for opportunities to grow, accepted *The Great Idea*. However, Signet wanted Rich and Nigel to come into the company not as consultants but as salaried bank employees with long-term bank contracts. Surprised by the offer, Rich and Nigel agreed to come into the company as heads of credit card marketing and strategy, but only under certain conditions: Rich and Nigel were to be given real bank titles, they were to have real control over systems, and they were to be accepted within Signet as line bankers. However, unlike main-stream employees of the bank Rich and Nigel

would retain significant profit-sharing potential. They believed that these conditions were necessary to allow their IBS to flourish.

David Hunt, Executive Vice President of Signet Bank, played a major role in the transition. Rich and Nigel also received support from Bob Freeman, then CEO of Signet. Perhaps most importantly, David listened to Rich and Nigel, had the vision to recognize the potential of their ideas, and helped to generate buy-in within the firm. As he stated, "You think that you can make IBS work? Then go do it!" His role included protecting Rich and Nigel and providing for their independence while simultaneously managing their relationships within the bank. He also provided funding needed to develop an IBS and to absorb the losses associated with the learning phases of their strategy.

3.2. Initial Performance

The initial period for Rich and Nigel at Signet ran from October 1988 when they entered Signet to December 1991. Nigel stresses that the first year entailed a large commitment to "infrastructure build: building databases, learning the trade of account management, and figuring out how to implement this very difficult strategy." In August 1989 they rolled out their test and learn solicitations in significant scale.

The initial implementation of their IBS was based on a "test and learn" methodology. In brief, test and learn consists of the following:

- Running some test marketing activities (e.g., sending out a small, yet carefully selected, sample of direct marketing solicitations)

- Determining which tests make money and which ones do not; this takes some time, and most of the tests will be unprofitable. However, unprofitable tests are not unsuccessful, if they enable you to determine the basis of profitable tests going forward.

- Then running more programs, more and more like the ones that proved successful in the initial test stage.

Unfortunately, there is a significant and expensive lag between the stage of initial "testing" and the stage where "learning" is realized and profits are earned. In fact, by December of 1991 chargeoffs from Rich and Nigel's 1989 solicitations had soared to 9.5%, more than doubling the chargeoffs of the bank's total portfolio from 2.6% in August 1989 to 5.9% at the end of 1991. As Rich notes, "Signet stock price was in free fall!" The stock price plummeted from over $20.00 in late 1989 to less than $5.00 in early 1991 (prices adjusted for a split in 7/93). According to Nigel, "We hit bottom in late 1991." From bank card profits of $27 million in 1988 and $25 million in 1989, forecast profits for 1992 had dropped to zero by late 1991. The fall in stock price was a result of bad real estate loans. Had the credit card portfolio profits actually dropped to zero the results for the stock price would of course been far worse; fortunately, the IBS began to produce profits at just this time.

Rich and Nigel, however, never lost faith in their basic conception of strategy for the bank; equally important, neither did David. They continued their focus on testing, nearly doubling the number of tests conducted from 335 in 1989 to 617 in 1991.

3.3. The Middle Period

Late 1991 began a period of triumph for Rich, Nigel, and those associated with implementing *The Great Idea*, which continued through the spin-off of Signet's credit card business to Capital One in 1994.

During this period (1992-1994), growth in receivables and in number of accounts soared [see Table 1], especially when compared to its competitors [see Figure 1]. At the same time, percentage chargeoffs improved and were consistently better than industry averages [see Figure 2]. Not surprisingly, the stock price of Signet Bank surged, allowing the bank to grow faster than 996 of the Fortune 1000! In

fact, Signet's stock appreciated 537% between January 1991 and the end of 1994 [see Figure 3].

The credit card operation at Signet was doomed by its own success — it could not continue as part of the bank. The credit card business came to account for roughly 2/3 of the profits of the bank. This threatened the stability of the bank's governance, when relatively young and relatively new additions to the bank were accounting for such a large portion of the bank's profits. Moreover, as Rich and Nigel began to envision new lines of business, many outside traditional banking, it was clear that they would require more freedom of action than would be possible within the structure of Signet. As a solution, Signet CEO Bob Freeman made the audacious decision decided to spin off the credit card business as a wholly independent company, not associated with Signet.

3.4. The Current Period

The current period can be considered the time from the spin-off in 1994 through the present. During this period, Capital One has continued to enjoy considerable success. They have achieved success as measured in terms of growth in number of accounts and total outstandings [see Table 1], as well as in low loan losses when compared to its competitors [see Figure 2 and Figure 5]. In addition, stock performance has been strong [see Figure 4].

Clearly, Capital One has experienced tremendous success. "By any measure, Capital One has more than tripled in the past three years." (Annual Report, 1995)

Capital One continues to rely upon Information-Based Strategies to acquire profitable market share and continues to rely upon *Test and Learn* methodology for developing and implementing those strategies. Indeed, testing continues at Capital One, as demonstrated by the exponential growth of its R&D efforts [see Figure 6].

3.5. Assessment of Capital One's Strategy

It is clear that Capital One has achieved competitive advantage. The bank has been outperforming most of its competitors in terms both of market share and of margins. Consequently, Capital One is outperforming most competing credit card issuers as reflected in its stock price. The firm's price has more than doubled since its 1994 IPO, significantly outperforming both the market as a whole and the banking sector.

4. How: Steps towards Achieving Competitive Advantage

There is little secret about either the extent of Capital One's advantage or the source of this advantage. The entire management team believes that the organization's success comes from its Information-Based Strategy and its reliance upon implementation of IBS via Test and Learn. "The success of Capital One has been the direct result of the proprietary information-based strategy that we have pursued since 1988. The strategy leverages information technology, scientific testing and a highly flexible operating infrastructure to deliver the right product, to the right customer, at the right time and at the right price." (Annual Report, 1995)

The core of this strategy is based upon the realization that customers differ widely in their profitability, and that information from a variety of sources can be synthesized to exploit this "customer profitability gradient." IBS represents the commitment to exploit this customer profitability gradient, and test and learn is the mechanism for doing so.

4.1. Implementation of Test and Learn

Rich Fairbank explains that in the late 1980s, when he and Nigel were attempting to interest bankers in a test and learn strategy, banks relied upon "black box"

credit scoring models that were used to determine whether or not to offer an account to an applicant. These black box models were usually procured from a vendor, and were "sealed" in the sense that the algorithms could neither be examined nor altered. While parameters could be updated based on experience, allowing the models to be tuned, algorithms could not be changed. These models were definitely not designed to learn which customers could profitably be offered accounts at different rates. Rich and Nigel thus advocated turning the credit scoring models off for test offerings, and developing and tuning their own models to determine which combination of product, price, and credit limit could be profitably offered to customers who could be characterized by a wide range of publicly available credit and demographic data. After a lengthy incubation period, it would be possible to determine which tests were profitable, and to rollout large profitable offerings corresponding to these smaller profitable tests.

The structure of this process explains the initial period of extremely unprofitable operations after the introduction of test and learn. The degree of trust needed to turn off the banks' credit scoring models likewise probably explains a great deal of the resistance that Rich and Nigel encountered when they attempted to create interest in their IBS approach.

4.2. The Balance Transfer Product

The first breakthrough offering discovered through this process of test and learn was the "balance transfer" product. This product offers customers a lower initial APR for applicants who transfer their balances from a competitor's credit card. It turns out that this transfer of balances by customers from higher APR credit cards to a lower one provides the card issuer with an important signal. Customers that do not carry balances find no value in a lower APR and will not take the time and effort to switch cards. More importantly, the customers that the balance transfer product will attract are those customers who have a balance they cannot presently payoff but which they will eventually payoff slowly. Therefore, they care about the lower APR.

Clearly, these customers meet Nigel Morris's characterization of great accounts: They borrow money, they pay it off, and they pay it off slowly. Or, as Rich Fairbank more flamboyantly says, "We found the elusive low-risk revolver" and "we hit the jackpot!" People who borrow more, and who approach the borrowing limits of their cards, tend to be riskier. A graph of percentage of loans more than 60 days delinquent, plotted against percentage of credit line utilized, clearly illustrates this trend. However, customers who accepted the balance transfer product exhibit much more attractive risk-utilization profiles, as shown in Figure 7.

The graph in Figure 7 can be summarized differently by noting that marketing expenses for the balance transfer product represents an investment in an annuity. Each dollar of expense invested results in an annuity stream of more than $2.25 in the first year, close to $4.00 in the second, close to $2.50 in the third year, more than $1.50 in the fourth year, and over $1.00 thereafter. Nigel summarizes the graph simply by saying "We found the sweet spot".

4.3. The Secured Card

Another product offering resulting from the test and learn methodology is the "secured card" product. Even high risk accounts can be made profitable if the rate is high enough and steps are taken to control losses. In other words, even among bad risks there are good and bad accounts, love 'ems and kill yous.

It is very difficult to function in our society without a credit card. Car rental companies, for example, will not rent to individuals who can only present a debit card. Their rationale is simple – renters are being given sole control of a new vehicle, often valued in excess of $20,000, and they want some indication of credit worthiness.

Capital One has products for individuals who are unable to acquire credit cards any other way. Some of these — the worst risks — are made safe by posting full

bonds. Others are allowed to post partial bonds — that is, bonds less than their credit limits — and to improve their credit ratings and APRs over time.

4.4. Other Products and Services

Capital One offers a whole range of products to credit consumers, including offers to students and to applicants without previous credit history. In fact, presently there are over 3,000 price points in Capital One's current offerings. Capital One has the ability to "customize everything". On account acquisition, they can customize on customer segmentation, market channels, products, pricing, credit lines, and credit approval policies. On account management, they can customize on repricing and retention, credit line increases and decreases, collections and recoveries policies, and cross-selling.

5. Sustaining Competitive Advantage

Why did so many powerful banks reject the strategic recommendations offered by Rich and Nigel? Why were they not understood and adopted by the banks and used as the basis of their strategies, even before *The Great Idea*?

Unlike other examples of our newly vulnerable markets paradigm, there was no rapid change in technology or regulatory discontinuity that suddenly made differential pricing possible. A steady decrease in cost of computing for analysis, and of costs of storage and classification for the creation of targeted mailing lists, had made information-based marketing and pricing strategies possible well before 1988.

The principal problems faced by banks in responding to opportunities in the market include their: 1) organizational structure, 2) information infrastructure, 3) organizational skill set, and 4) organizational culture.

5.1. Bank Structure

Most competitors have, or used to have, two very separate organizations responsible for credit cards. The marketing department is responsible for selling; it is their responsibility to maximize the number of cards issued and the total balances outstanding. In contrast, there is also a credit department, and it is their responsibility to minimize exposure to bad loan losses, by limiting who has access to cards and what balances they are allowed. These two groups are in constant tension, but they are frequently poorly coordinated or not integrated at all; indeed, we have all heard stories like the credit department of the a major card issuer refusing a charge that would have put a good account less than $10 over the card holder's limit; days later the furious cardholder was notified by the marketing department that his line of credit had been extended by $5,000, just after the enraged customer had canceled his account.

In contrast, Rich and Nigel employed an integrated, risk managed, approach to sales and marketing that attempted to compute the expected NPV or annuity value of each new account, providing first Signet Bank, and now Capital One, with the ability to respond appropriately to situations like that described above.

5.2. Information Infrastructure

To support its IBS, Rich and Nigel believed that they had to invest heavily in information technology. At Signet they developed what was considered at the time to be the largest Oracle database in the world. The database not only contained detailed data on customers (i.e., their demographics, purchases, activities, etc.), but also supported regressions and other analytics, and stored the results. The generation and storage of such data analysis led to the enormous growth and size of their database system, and enabled Signet to identify profitable marketing opportunities; the systems continue to support Capital One's marketing efforts.

This is in sharp contrast with the actions of competitors, some of whom have outsourced all non-branch customer contact, and do not maintain their own databases or do their own servicing. As Nigel has said, "This is equivalent to outsourcing your sensing and your decision functions; it's like trying to do planning after you've put your planning department through a guillotine!"

This view that infrastructure provides critical value is shared throughout the organization, where it is widely believed that the necessary flexibility cannot be achieved in organizations that outsource their data processing. Indeed, in 1994, the year of the spin-off, Capital One was willing to incur the expense of $49 million to break its long term outsourcing contract with EDS, since it was seen as necessary to do so in order to achieve maximum flexibility for the new company (Anthes, 1995).

5.3. Organizational Skill Set, Culture, and Commitment

Bank structure and information infrastructure would not achieve advantage without the skill set to exploit them and the commitment to hire and train the right people. The following example of unsuccessful attempts at differential pricing at a competing bank demonstrates that the execution of pricing strategies is complex.

One major competitor began to lose a significant number of its best accounts to Signet; it was not initially concerned because the loses were averaging only 3,000 to 4,000 accounts a month. Concern began to increase only when it was noticed that these were uniformly low-risk, high-balance revolvers[3]. The bank did not initially respond with sufficient price cuts for their best accounts and profitability eroded. The bank eventually decided to move towards differential pricing, but

3 ***Revolvers*** are cardholders who chose to pay off their accounts slowly, unlike ***transactors***, who pay off their accounts in full at the end of each payment period. Transactors use their cars for convenience, as charge cards rather than as credit cards, and offer their banks no opportunity to earn interest payments; indeed, these accounts are benefiting from the ***grace period*** each month that enables them to enjoy the "float" on their accounts without incurring charges from the bank. In contrast, revolvers generally pay finance charges each month and thus as a group are much more profitable for their issuers.

began by raising the prices for the wrong accounts, driving away many of their good risks. To recover and halt the erosion, they put in across-the-board reductions in APR for their remaining accounts, and thus were left with a portfolio of poorer risk accounts at lower APR rates; the results were disastrous.

At Capital One, successful implementation of their more complex strategy begins with hiring the right people. According to Nigel, "We compete with McKinsey for the best graduate students; we're not competing with commercial banks... Above all, we know that the key to our success has been and will continue to be our commitment to hiring and developing incredibly talented and motivated associates." This appears in the Letter to Stockholders, in the company's Annual Report for 1995, and similar thoughts are unlikely to be seen in any form in the annual reports of more traditional banking companies.

In addition, the success experienced at Signet and Capital One requires commitment to a long term strategy of identifying and solving problems. Nigel claims that "if none of your initial tests lose money, you're probably too conservative for us. If you can't figure out why they lose money and solve the problems, you're also probably not right for us; we need people with tenacity and superb problem solving skills." Nigel also notes that "We truly believe that we have put in place a *better mousetrap*. Duplication of the strategy by the competition is very difficult, and would take them years of patient investment."

While it may be clear what changes competitors need to make to respond to Capital One, it is also clear how very difficult it is for most organizations to accommodate such profound change. Tushman and Anderson (1986) and Tushman and Romanelli (1985) describe the extreme difficulty organization have dealing with "competence destroying change" — changes that devalue existing skill sets and competencies. Banks that wish to respond to the changes initiated by Rich and Nigel need to change the fundamental skill sets and strategies of their employees. Therefore, such changes will be very difficult to achieve. Levine and Rossmoore (1992) further note that there is even great difficulty in simply discussing the need for such profound change within an

organization. Clemons (1997) has observed ways in which past success is codified in *doctrine*, which limits the ability to perceive or imagine environmental change. This creates difficulty in seeing the need for profound change in strategy, even in the presence of increasingly unambiguous environmental signals, like loss of profitable market share to a single competitor following a public, demonstrably different strategy.

In summary, Capital One senior management believes that their advantage has been sustainable because it is based on a complex combination of structure, information, skills, culture, and commitment.

6. Future Opportunities

That said, senior management also believes that it will become more and more difficult to sustain this advantage. As other banks begin to follow similar strategies and as competition increases it will become more difficult to maintain margins. Therefore, it will be necessary for Capital One to continue to refine its offerings.

When AT&T offered all accounts the same service and the same price, Signet had 23 price points. When AT&T had over 20 price points, Signet had over 300. Now that AT&T has over 300 price points, Capital One has over 3,000. Indeed, a senior officer at AT&T UCS believes that all competitors will be forced to adopt similar strategies. According to Nigel, "When one of your competitors begins down this slippery slope, you have no alternative but to follow."

Scott Barton, Director of New Business Development (or the Growth Opportunities Team), believes that ultimately, all accounts will be priced efficiently to reflect their risk adjusted expected return, a complex way of saying

that in credit card issuing, as it is presently structured, it will become increasingly difficult to be profitable for any issuer.[4]

However, profitable opportunities are likely to continue as long as competitors are less able than the bank to assess the profitability of their accounts. Capital One employs *retention specialists*, whose job is to keep customers who call to cancel their accounts. Retention specialists are supported by screens and computer models that indicate the effects on profitability of changing a customer's APR. While they are empowered to lower a customer's APR down to just above the break-even level, their compensation system rewards them not only for retaining profitable accounts, but for retaining them at the highest possible APR.

Further evidence of increased competition is the fact that the balance transfer product has come under assault. According to Nigel, "The balance transfer product, which we pioneered in 1991, has enjoyed such spectacular success that the market has become increasingly competitive. While we will continue to pursue profitable balance transfer opportunities, we have begun to roll out the next wave of market-tested credit card innovations."

The Growth Opportunities (GO) Team originates from the belief of senior management that the skill set, personnel, culture, and infrastructure of Capital One can be used in other settings, to develop and market different products in different, perhaps unrelated industries. "In the long run, we see our destiny not merely as a credit card company, but as an information-based marketing company offering a variety of products in information-rich industries." (Annual Report, 1995). Rich augments this as follows, "We have never viewed ourselves as just a credit card company. We're an information-based marketing company. The credit card just happens to be a product which has been transformed by the information revolution."

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4 Unfortunately for banking as an industry, there is considerable evidence to support this concern. The assessment of technology in banking suggests that even as it creates value for customers it increases competition and the efficiency of pricing, destroying profits for financial intermediaries (Steiner and Teixeira 1990).

There are other newly vulnerable markets, and hence other opportunities for a new entrant like Capital One to use information-based strategies to target an established competitors' most profitable customers. Capital One wants to focus the core team on areas where Capital One's core strengths can provide advantage, and yet to avoid having too focused or too restrictive a view of what these strengths might be. As Peter Schnall, Vice President of New Business Development, says, "We want to make certain that we are not being too narrow in our view of future opportunities. Are we going to attack opportunities in banking or in market segmentation? Is our core strength in information-based strategies for test and learn targeting of profitable new accounts or in the use of information more generally for relationship management?"

The GO Team is presently assessing opportunities in a wide range of industries. The company is making increasing investments in non-card targeted marketing; expenditures in 1997 are estimated to be split among balance transfer, other card products, and non-card products, with GO and other card products expenditures roughly equal and both substantially greater than balance transfer product expenditures. The team is, however, all too aware that unfortunately there will once again be a considerable lag between initial tests and profitable rollouts, especially in areas where they must first create a legal operating entity, gain new industry expertise, develop systems and operating infrastructure, create their tests, allow them to incubate and then tune their models, all before profitable rollout can be attempted. The senior management team also believes that there are enormous opportunities to exploit similar strategies in markets outside the U.S.

7. Conclusions

It appears clear that the history of Capital One and Signet Bank provides considerable support for our theory of newly vulnerable markets. The erosion of profitability however suggests that without fundamental differences in resources, innovations like differential pricing and effective market

segmentation will become strategic necessities rather than continuing as sources of competitive advantage. If the skills required for information-based strategies are sufficiently difficult to acquire, and if they are sufficiently general in their applicability, then Capital One should enjoy a prolonged period of profitability, exploiting a sequence of opportunities in newly vulnerable markets in other industries. Rich believes that this, indeed, will be the long term source of Capital One's competitive advantage, rather than its positioning in any specific product, industry, or market segment:

> "Capital One's competitive advantage is that the entire company is built around the information-based strategy — the people, organizational structure, systems, operations, accounting systems, human resources, policies, and, most importantly, the culture. We are building a machine that can identify opportunities, adapt infrastructure, and roll out products at full speed. While those opportunities grow, we work in parallel to plan for their eventual obsolescence. This company can turn on a dime. We're built for change."

While in hindsight test and learn strategies applied to newly vulnerable markets may appear to be obvious, clearly at the time they were anything but; major banks not only failed to perceive the opportunity, they were unwilling to accept it when offered to them. This may not be surprising. As Abraham Edelcrantz, the inventor of the optical (semaphore-based) telegraph noted:

> "It often happens, with regard to new inventions, that one part of the general public finds them useless and another part considers them to be impossible. When it becomes clear that the possibility and the usefulness can no longer be denied, most agree that the whole thing was fairly easy to discover and that they knew of it all along."

The Capital One team sums up these sentiments more tersely:

> "Our growth is the result of opportunistic origination and account management. The strategy was the easy part. Making it work was the challenge! We also continue to test the application of information-based strategy to other products, both financial and non-financial, with positive results."

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Table 1:

Number of Accounts and Amount of Receivables for Capital One

(000s)	1992	1993	1994	1995	1996
Loans	$1,452,742	$3,265,565	$6,197,423	$9,089,278	$12,804,000
Accounts	1,672	3,118	5,049	6,149	8,565

Figure 1:

Since 1992, Capital One's Growth Has Outstripped Most Competitors

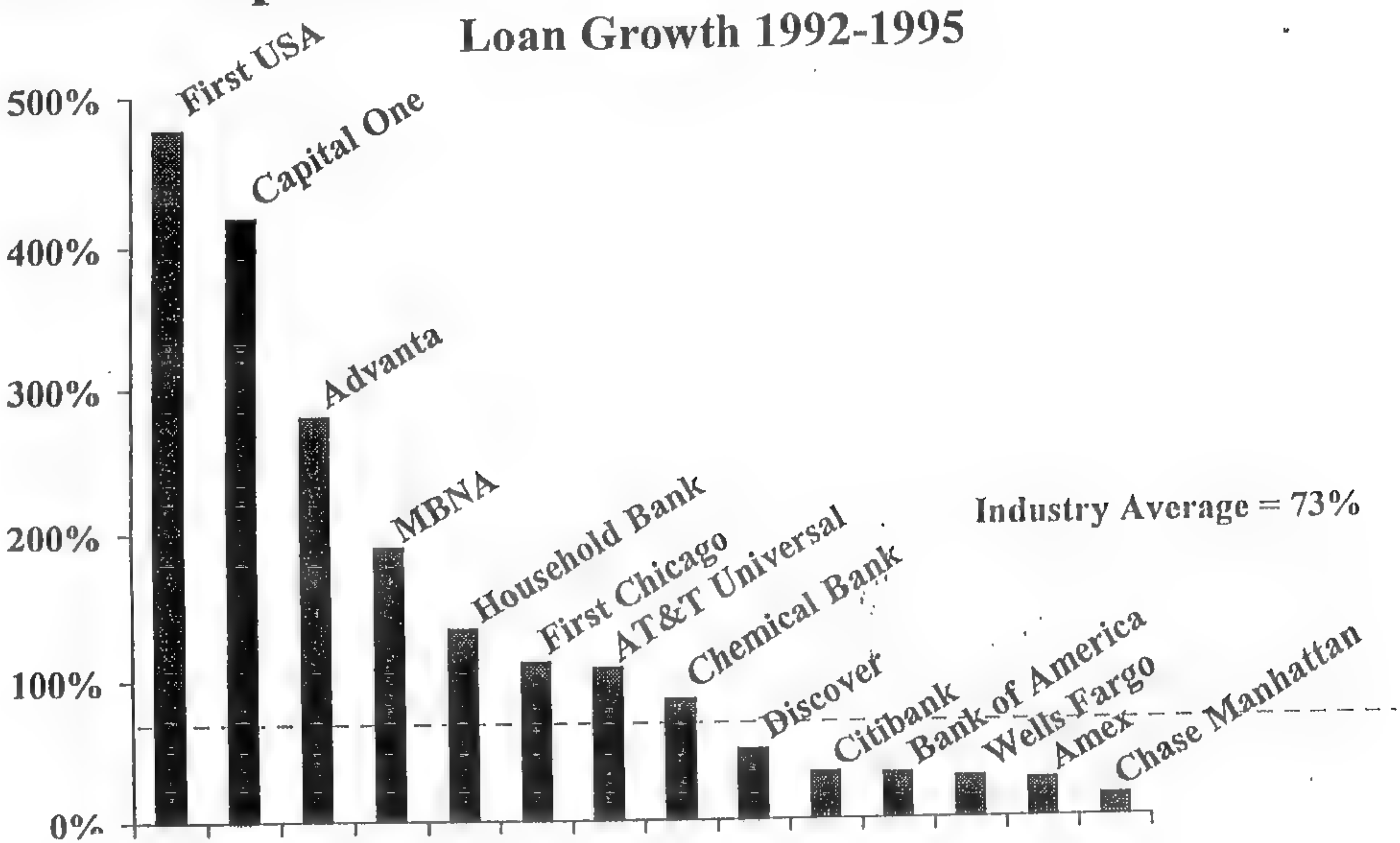
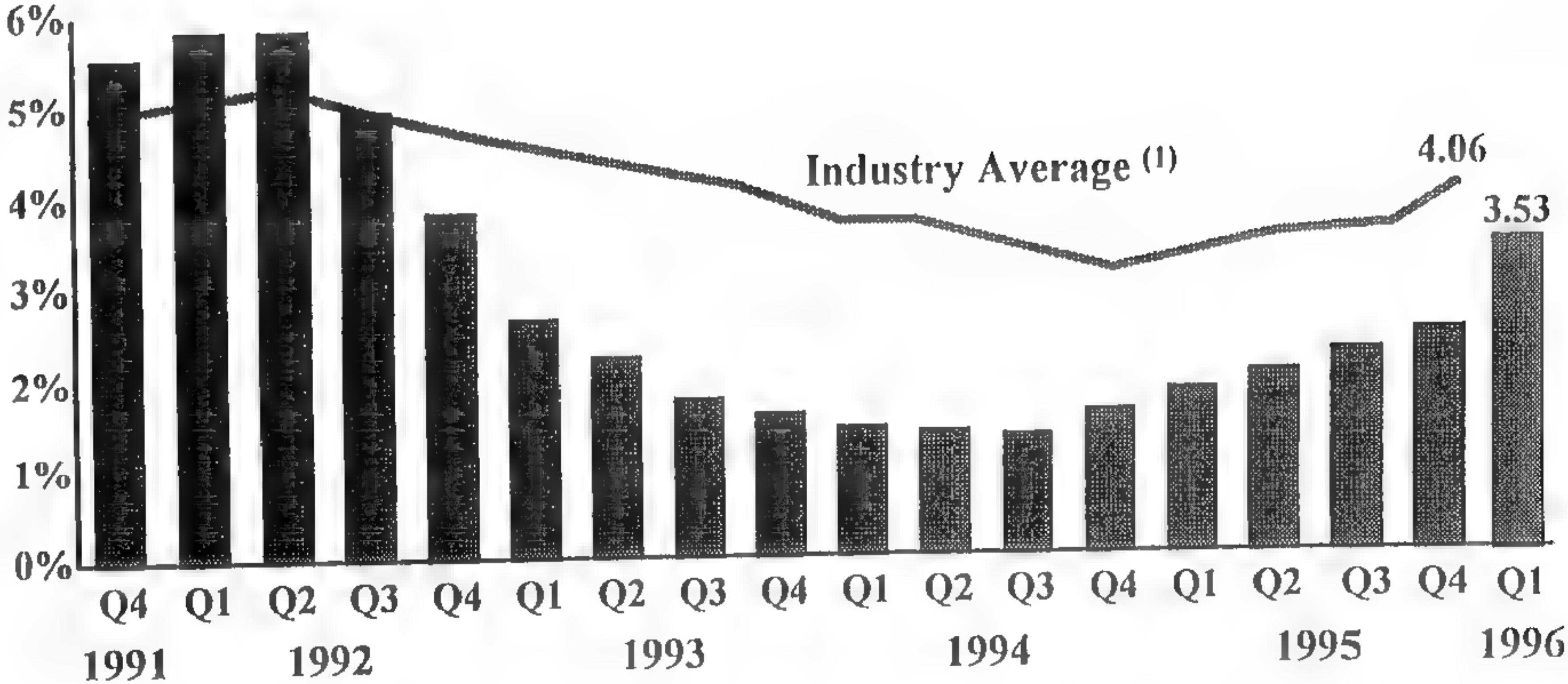


Figure 2:

Our Charge-Off Rate Remains Below the Industry Average

Percent Charge-Offs

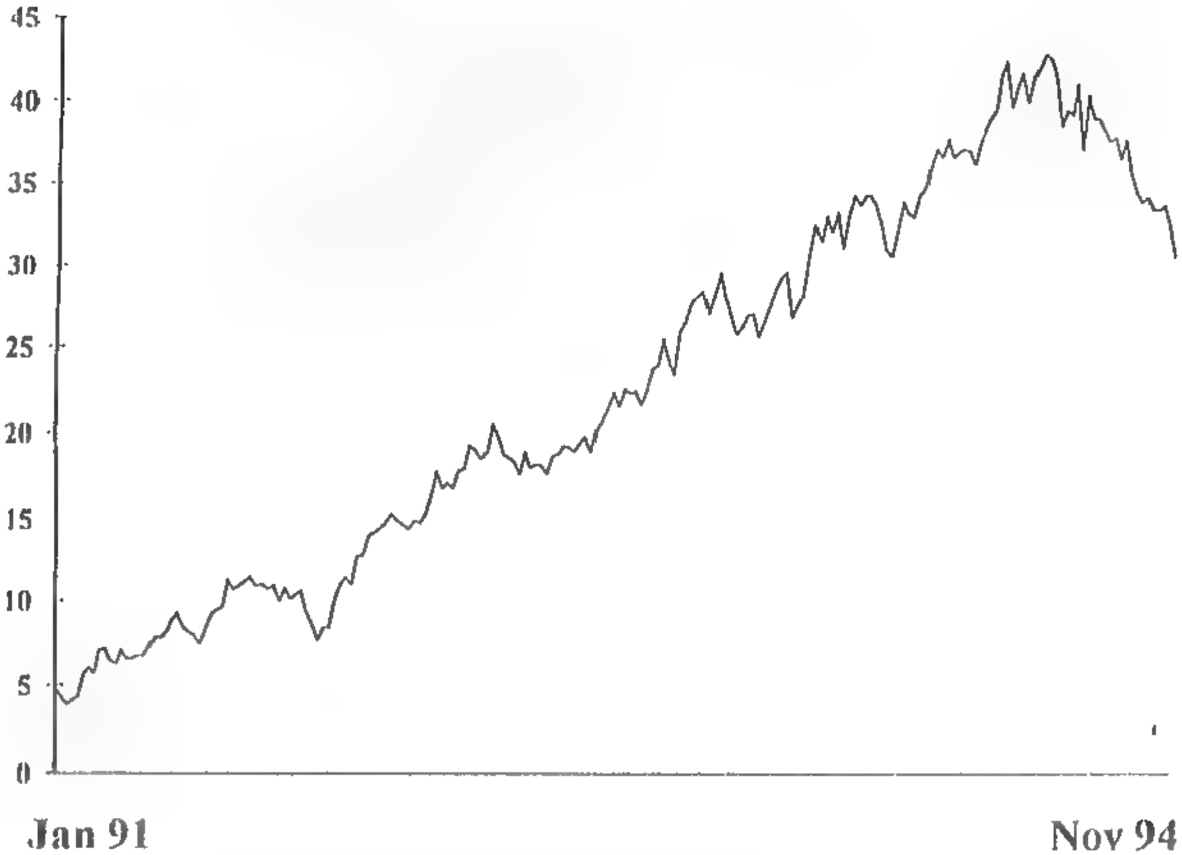


(1) Source: Visa and MasterCard

Stock Price Has Risen Steadily

Figure 3:

Signet (Before Spinoff)

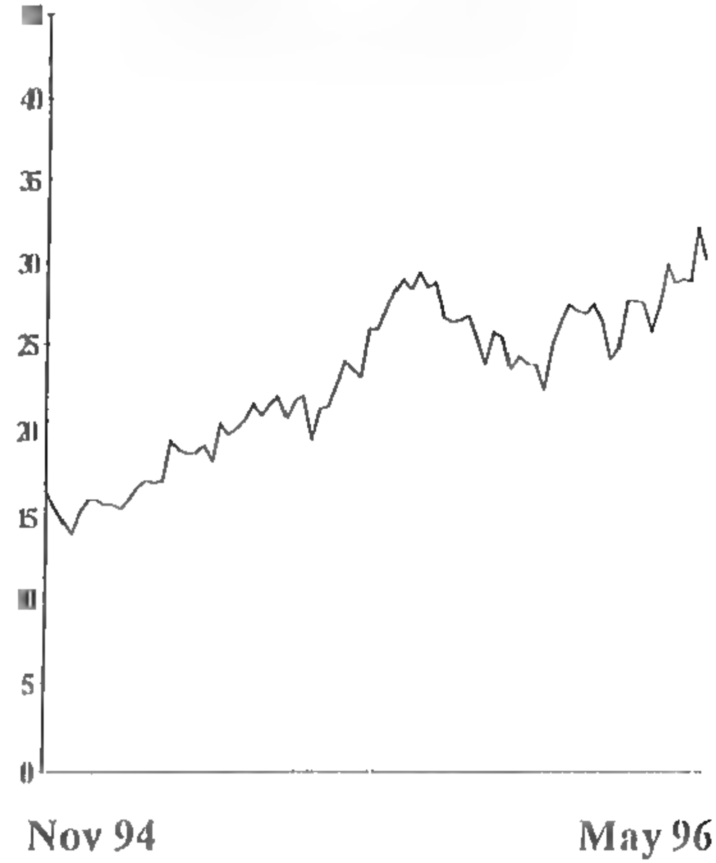


Price Increase of 537%

(Exceeded by only 5 companies on the New York Stock Exchange.)

Figure 4:

Capital One



Price Increase of 83%

Figure 5:

Several Major Competitors are Experiencing High Charge-offs

Percent Charge-Offs

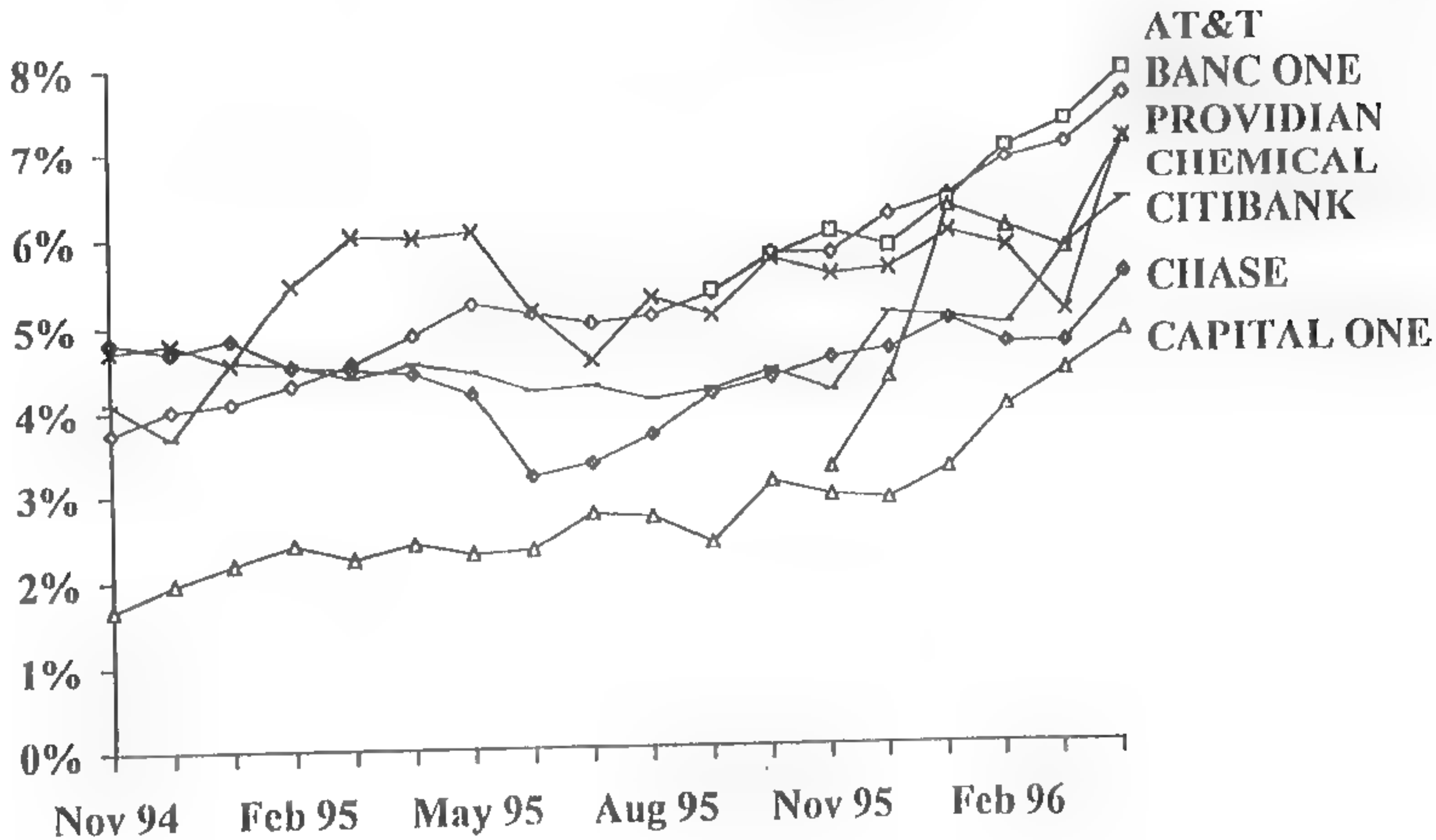


Figure 6:

Our R&D Effort has Grown Explosively

Number of Tests

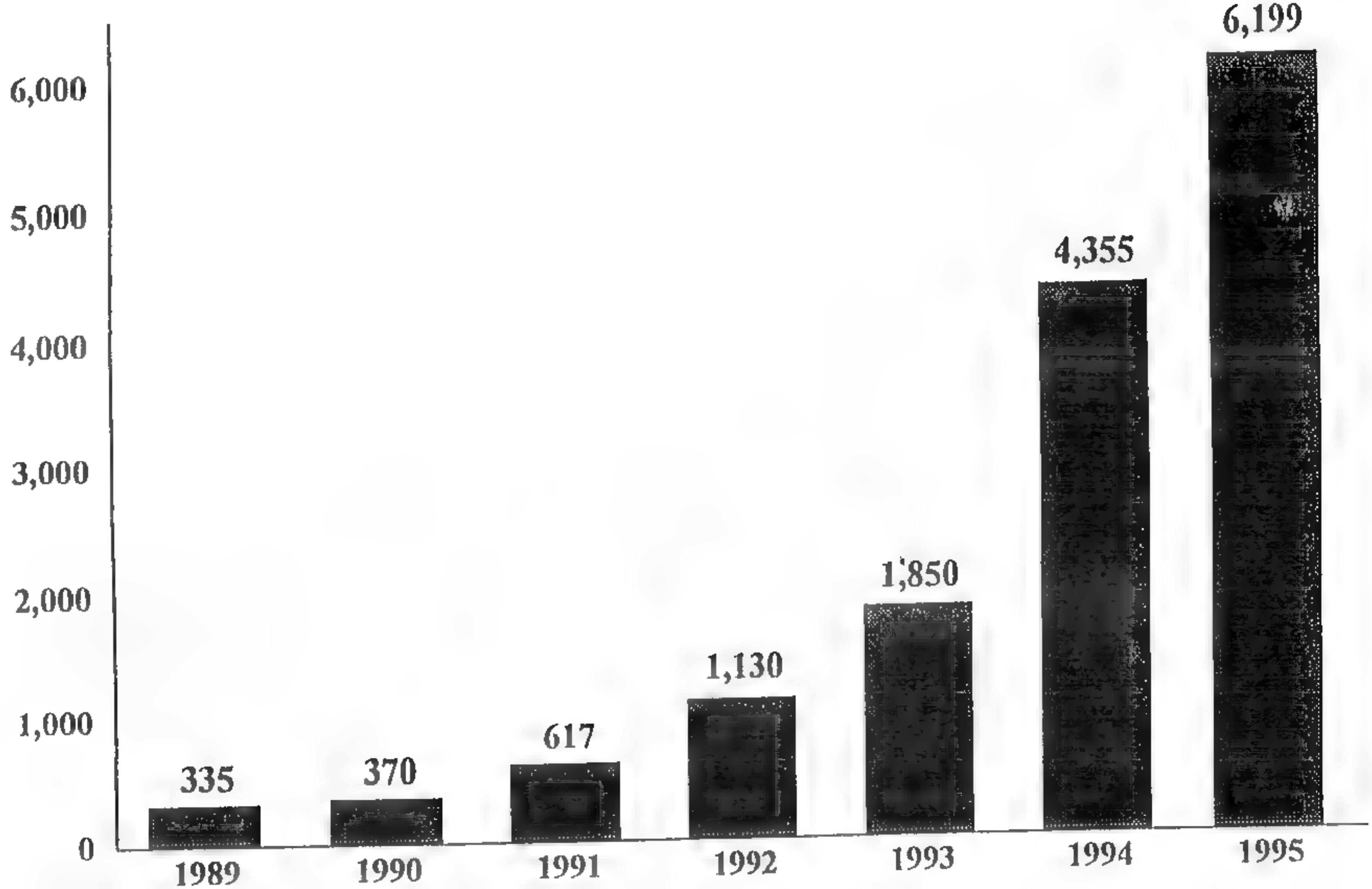
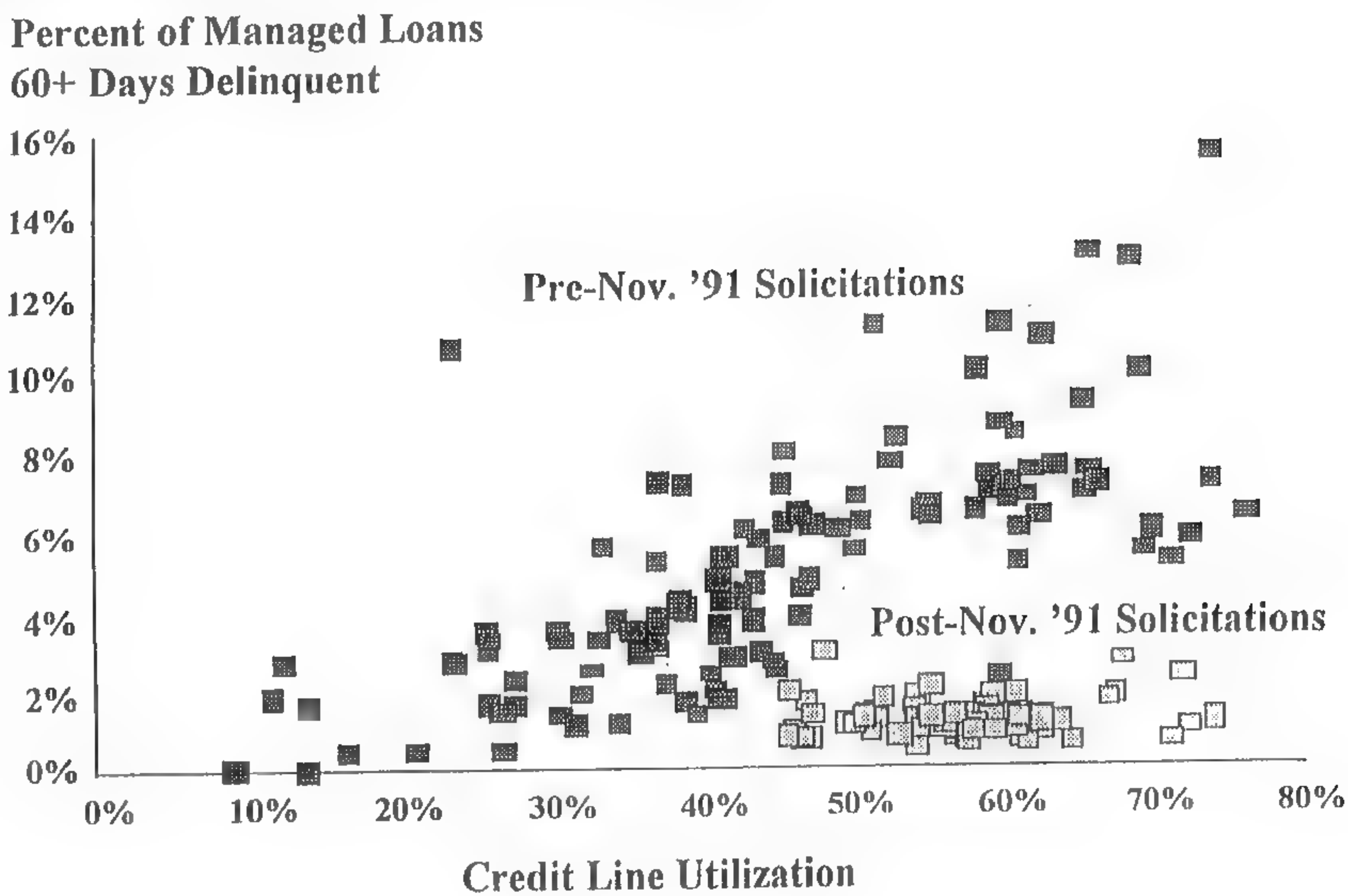


Figure 7:

We Found the Elusive Low-Risk Revolver

Solicitation Results (1 year after booking)



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BAXTER HEALTHCARE CORPORATION: ASAP EXPRESS

Prepared by Professor Benn Konsynski and Associate Professor Michael Vitale as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

In late 1987 the Hospital Systems Division of Baxter Healthcare Corporation (Baxter) and three hospitals of the Premier Hospitals Alliance began a pilot test of the ASAP Express computerized order entry system. The new system would allow orders to be placed with all participating vendors in a standard format, from the same terminal, and with a single telephone call. An outgrowth of the fabled ASAP system, ASAP Express offered a "level playing field" that gave no advantage to any one vendor.

"As a single-vendor purchasing order entry system, ASAP had given American Hospital Supply Corporation, and now Baxter, a distinct competitive advantage," said Michael Hudson, president of the Hospital Systems Division. "By now, most of the major medical-surgical and laboratory suppliers have developed order entry systems of their own. Some of these are on a par with our system, and it is not uncommon to find hospitals using multiple order entry systems. Each system requires a separate phone call and user protocol. This increases the amount of time it takes to place orders, and has resulted in customer demands for consolidated systems where supplies from all vendors can be ordered. The once strong product pull through effect of electronic order entry systems has lessened in recent years, due to the proliferation of systems. ASAP Express opens a new era of electronic order entry in which suppliers must compete in other areas such as product line breadth, distribution capabilities, and value added services. This is where Baxter truly excels."

Baxter Healthcare

After the merger with American Hospital Supply Company in 1985, Baxter developed, manufactured, or distributed more than 120,000 products for use in hospitals, laboratories, blood and dialysis centers, nursing homes, physicians' offices, and at home. The company could provide about 70% of a hospital's supply needs and nearly 100% of a blood or dialysis center's. Computerized systems for ordering, tracking, and managing supplies, both internally and at customer sites, were a significant company strength.

Changes in the Health Care Industry

Following World War II, the government began to increase support for health care, regularly increasing funding for the National Institute of Health, supporting community hospitals and increasing the doctor pool In 1965, Medicare came into being as one of the highest priorities of the Great Society initiatives. The practice developed to reimburse hospitals for costs rather than contracted rates, with the government retaining little control over the program or its costs. In the 1970s, government policy shifted from redistribution to regulation as costs rose out of control. In 1970 health care costs were 7.2% of GNP Soon, Certificate of Need programs developed to curtail hospital construction and local agencies were mandated by the government to monitor and control resource utilization.

By 1980, health care costs accounted for 9.4% of GNP. In 1982, Medicare reimbursement changed to a scheme based on diagnostic related groups or DRGs. The result was a reduction in the rate of cost increase. In 1984, doctors shifted to a national fee schedule for medicare work. After some slowdown in cost increase, health care costs continued to rise, representing over 11% of GNP by 1988.

By the middle of the 1980s, the health care industry was in the midst of dramatic change, with hospitals feeling extraordinary pressures. Fixed-rate reimbursement from the government sponsored Medicare program, which paid for 40% of all hospital patient days, had made hospitals much more cost-conscious. Businesses and insurers also were exerting pressure to cut health care expenditures. Hospital admissions were declining, and the average hospital stay had shortened to less than seven days. The total number of hospitals had declined from a peak in 1980, although the number of beds had increased slightly.

Aggregate demand for health care would likely increase, but more slowly than in the past, and customers would exert more choice. More and more care would be moved outside of hospitals to alternate sites, such as doctor's offices and walk-in emergency and surgical centers, and health care maintenance organizations (HMOs) would continue to proliferate. At the same time, hospitals would enter into less traditional markets, such as occupational health care and "wellness" programs, sometimes in partnership with physicians, nurses, and other providers. The fragmented supplies market participants focused on reducing their operating expenses and increasing sales. Margins were particularly attractive on products that the suppliers manufactured in-house.

In the past, and in many hospitals today, in each hospital there might be as many as 10 different buyers--the pharmacy, food service, anesthesiology, and so on--and even in hospitals that had adopted centralized purchasing, individual department heads and physicians often remained powerful buying influences. The price of each item was negotiated by the customer and the sales representative, making billing a complex process.

Supplies in hospitals were receiving more attention than in the past. They made up an estimated 10-15% of hospital costs, while the logistical expenses associated with supplies made up another 20-30%. Many hospitals were centralizing their purchasing functions and creating a more "professional" purchasing and materials handling function. The suppliers, many with their own sales force, often tried to establish direct linkages with the hospitals buyers, threatening the distributor's role. Hospitals sought to create buyer groups and leverage the trend in hospital consolidation to increase their power.

Although there were hundreds of competitors, and the barriers to entry in the hospital supplies industry were low, there were only a few distributors of any significant size. They competed on price, delivery, inventory, quality, and relationships with the buyer

representatives. The distributors were well aware that consolidation of hospitals would continue and that cost containment programs would grow in importance.

The Beginnings

"The Computer is at the heart of our success," said Karl D. Bays, Chairman and Chief Executive Officer of American Hospital Supply Corporation (AHSC) in early 1985, describing the importance of information systems to the company. Traditionally, AHSC's products had been sold by its field salespeople, who worked from their homes and called directly on hospitals and other organizations. Until 1964, orders were generally taken in person by the salesperson, who would then mail the orders to company headquarters. Bays, who joined AHSC in 1958 as a salesperson, recalled that upon arrival in a town he would immediately find out when the last mail of the day went out. " When I had made my calls," Bays continued, "I would rush back to my hotel room and write out all my orders and customer inquiries and get to the post office in time to make the last mail. That was an imperative." The paperwork could be formidable: an 800-bed hospital might easily stock 30,000 items and generate 50,000 purchase orders per year--at an estimated preparation cost of $25-30 each.

In 1957 AHSC had begun to automate its order entry and billing procedures by installing IBM 632 tab-card billing machines in its distribution centers. Orders received at the centers would be keypunched, and the cards were fed through the billing machines. A packing list for the warehouse was produced, as was a summary card for the accounts receivable system. The line item cards from the order were sent on to the home office for sales analysis.

In the early 1960's one of AHSC's West Coast offices began having difficulty servicing a large hospital customer. Orders were frequently delivered late and incomplete, creating problems for both the customer and AHSC. The West Coast office manager put an IBM 1001 Dataphone in the hospital's purchasing department and attached an IBM 026 card punch in the AHSC distribution center to a phone line. The hospital was given a box of prepunched cards--one for each item purchased from AHSC. The cards were physically placed on the shelves of the hospital's stockroom, each card stuck between boxes of supplies at the point where more stock should be ordered. When the box above the card was taken from the stockroom, the prepunched card was added to the pile of items to be ordered. On a regular schedule the hospital connected the 1001 Dataphone to the 026 card punch via telephone. Each card was fed through the Dataphone, causing a duplicate to be punched by the 026 at the AHSC distribution center. The result was a duplicate deck representing the hospital's order. This deck was fed through the 632 billing machine and the order process continued as usual. The hospital was able to speed up communications and thus could reduce its inventory. Orders were more accurate and more timely. AHSC benefited as well, and decided to offer the 1001 Dataphone-based service to other customers. More than 200 agreed immediately and the system, named Tel-American, was extended to other West Coast customers, then to Chicago, and then to other areas. A similar service, Telephone American, worked in somewhat the same way but without the 1001 Dataphone. Instead, the prepunched cards were kept in a box at the AHSC office, and customers called in their orders. The cards were taken from the box manually by the telephone order entry clerk.

Tel-American was well in place by 1969, when Gary Nei was hired as product manager for systems marketing and asked to identify additional customer benefits of the system. "The 1001 was the nucleus but not magic," Nei said later. "The customers could just as easily phone in their orders, and many did. The question was how to bundle additional services." Nei read the relatively small amount of material then available on materials management and wrote a document translating the general theory to the hospital

environment. He began to advocate a "prime vendor" approach, in which hospitals would contract to obtain a major portion of their supplies from AHSC. In return, the hospital would accrue the benefits of lower inventory, reduced paper handling, lower "shrinkage" due to loss, spoilage, and theft, fewer purchase orders and deliveries to handle, and guaranteed service. Tel-American was promoted as part of an overall hospital materials management system. Nei worked with the field sales force to educate and bring home to hospitals the benefits of materials management and to obtain commitments to implement the required disciplines and procedures. In some cases Nei and his staff swept stockroom floors and physically rearranged inventory in order to get a customer started. Later, as rising interest rates made holding inventory more expensive and as hospital purchasing agents began to understand their ability to become more professional through the use of modern techniques, the concepts promoted by AHSC became widely adopted. "We changed the industry," Nei noted, "we really did."

By the mid-1970s some of the novelty of Tel-American had worn off, and IBM had decided to drop support for the 1001 Dataphone. In response, AHSC's laboratory manufacturing division, TekPro, designed and built a much faster device to read and transmit data from cards. By this time, AHSC had installed a mainframe computer system that kept track of orders and inventory, and the TekPro device was attached to this system rather than to a reproducing card punch. The TekPro unit also allowed the hospital to enter some data--for example, order quantities--by hand; more important, it acknowledged that each line of data had been received correctly. The new order entry system, with mainframe computer support, was called Analytic Systems Automatic Purchasing (ASAP).

The ASAP System

Both the Tel-American system and its successor, ASAP, were essentially one way linkages; although special inventories were reserved to Tel-American and TekPro users, the customer could find out for certain when the ordered items would be delivered and in what quantity only by phoning the AHSC office or by waiting until the AHSC truck arrived. The TekPro unit was highly reliable--some were still in use in 1985--but customers' needs for a printed response led to the adoption of the Bell 43 terminal as a standard input and output device in 1977.

The printing device and steady improvements in its central computer software gave AHSC the ability to respond to customer orders by verifying the item number and showing the availability and price of each item. Items could be ordered using AHSC's catalog numbers or those of its competitors, and orders could be edited for accuracy and completeness before they were transmitted. For items that were not currently in stock, the system could often recommend a substitute but did not make any substitutions automatically. The enhanced system, called ASAP 2, also allowed messages to be transmitted electronically among AHSC, the sales representatives, and customers. As with earlier systems, customers who used ASAP 2 paid for the terminal themselves; AHSC paid the telephone line charges.

In 1980 AHSC announced ASAP 3, which allowed customers to enter orders using the hospital's own internal stock numbers. Customers could also build electronic files for standing orders and for repetitive orders. These files shortened the customer's order entry time and improved ordering accuracy. ASAP 3 produced output to customer specifications as well, including inventory lists, purchase orders, and requisition forms. The customer could inquire on-line into pending back orders, prices, and delivery dates. Like its predecessors, ASAP 3 was intended to be used as part of an overall materials management program. The system did not, however, actually manage the hospital's inventory. An enhancement, ASAP 3 PLUS, incorporated bar code scanning of shelf labels, requisition

forms, or a catalog to facilitate order entry. Over the next few years, teletypes, CRTs, and other "dumb" terminals were added to the list of devices supported by ASAP.

ASAP 4, a computer-to-computer order-entry system, was released in 1983. It simplified the hospital's purchasing process by eliminating all the manual steps except actual approval. The customer's internal computer system produced recommended orders that, once approved, were automatically transmitted through a high-speed phone connection to AHSC's mainframe. Order confirmations were sent directly to the customer's computer system to update the hospital's files. Hospital size did not always correlate with information systems capability: some small hospitals were relatively sophisticated, while some very big hospitals relied almost totally on manual systems. Nevertheless, it was expected that ASAP 4 would be used initially by the major multi-hospital groups who had corporate agreements with AHSC.

Each hospital placed its ASAP 4 orders at prearranged times of the day; the system was not designed for emergency orders. Customers did not pay for the use of ASAP or for any necessary software customization, which could take up to eight hours of work.

ASAP 5, which went into pilot use in December of 1984, promised to extend the capabilities of ASAP 3 by using an IBM Personal Computer (PC) as the customer's input and output device. Customers could build and edit order files on the PC instead of on-line, thus reducing telephone expenses. The PC was equipped with extensive tutorial software, allowing a new user to learn in about 15 minutes how to enter ASAP orders. The new system would be menu-driven and would include a HELP facility that could be accessed while entering an order. As in the past, the hardware would be supplied by the customer.

By late 1984, ASAP and a few AHSC financial applications were running on five Burroughs mainframes. About 50% of AHSC's hospital orders came through ASAP. The ASAP software, which had been written totally by AHSC, was in a mixture of ALGOL and COBOL. A program to convert ASAP to IBM hardware had been under way for a year and had another 18 months to go. Looking back, AHSC estimated that it had spent about $30 million to build ASAP. Ongoing maintenance required six to nine full-time people. Annual operating costs for the 9000-terminal system were about $3 million.

AHSC had also implemented VIP, a "reverse ASAP" that linked the company to its suppliers. Purchase orders were transmitted to suppliers electronically, as were messages about inventory levels, pricing information, and so on. VIP was not mandatory, but the benefits of faster communications were sufficient to convince most suppliers to use the system.

Merger

The first quarter of 1985 was a difficult period for American Hospital Supply Corporation (AHSC), by now the country's largest seller of medical supplies. The increasingly competitive health care industry was watching costs more closely than ever, and AHSC's sales fell 4% from the first quarter of 1984, while net income declined by 16%.

On March 31, 1985, AHSC stunned the health care industry by announcing plans to merge with Hospital Corporation of America (HCA), the largest U.S. hospital management company. With 1984 revenues of $4.2 billion and earnings of $297 million, HCA owned 420 for-profit hospitals and planned to spend $1.2 billion in 1985 to build and acquire more. The merger was intended to guarantee HCA supplies at the best price available while offering AHSC an opportunity to diversify. The combined company planned to acquire nursing homes and clinics, and to develop out-of-hospital medical care programs.

While little difficulty was expected in gaining the approval of the Federal Trade Commission, serious objections were voiced by some of AHSC's customers, who competed directly with HCA, and by the AHSC sales representatives who served those customers. In the months following the announcement of the AHSC-HCA merger, the share prices of both firms declined, and AHSC lost business as some customers that competed with HCA took their business to other supply firms. On June 20, Baxter Travenol Laboratories, Inc. (Baxter), a medical products company with annual sales of about $1.8 billion, made an unexpected bid for American Hospital Supply.

Baxter offered $50 a share for half of AHSC's shares and debt securities of equal value for the other half. The merger of AHSC and HCA would have brought AHSC shareholders stock valued at about $36.50. AHSC's directors rejected the Baxter proposal, citing fears of antitrust violations. Baxter agreed to sell some $500 million of assets that would overlap and continued to press its offer. AHSC's stockholders, particularly institutional investors, made known their preference for the higher bid. After three weeks of often-bitter wrangling, AHSC's board accepted a $51-per-share offer, in cash for up to 53% of the company's shares and in securities for the remainder. "Baxter Healthcare Corporation" was the name adopted in mid-1987.

Prior to the merger, Baxter Travenol had been primarily in the intravenous therapy business. Its product line of some 7,000 items was shipped from 25 distribution centers. American Hospital Supply had distributed 150,000 items--none of them manufactured by Baxter Travenol--from 150 centers. Baxter cited AHSC's strengths in distribution, corporate sales programs, and information systems as significant factors leading to the merger. In the face of strong competition and continued cost pressures in the health care industry, Baxter's earnings had fallen somewhat and the company had instituted cost-cutting measures, including by mid-1987 the reduction of some 3,000 overlapping positions from the immediate post-merger workforce of 62,100.

In addition to differences in product line and size--AHSC's sales had been almost twice as large as Baxter's--the two companies differed in culture and structure. Like AHSC, Baxter had a relatively large number of MBA's, including president Vernon R. Loucks, Jr., who became the chief executive officer of Baxter Healthcare. AHSC's management, including president Karl D. Bays, were generally described as somewhat more sales oriented, entrepreneurial, and willing to take risks. "At AHSC we used experience and good gut feel," one vice president noted. "while Baxter used analysis. The merger married the two strengths."

Baxter had generally been more centralized than the more diverse AHSC, and the structural differences extended to information systems as well. Carl Steiner, who had been vice president for information resources planning and administration at AHSC and held the same title at post-merger Baxter, recalled that Bays had once told the head of AHSC's data processing department, "Do whatever you want to do as long as it's right--and I'll tell you if it's not right. If you can sell what you develop to the divisions, fine; if they don't want what you have, they can build their own." At the time of the merger, one-third of AHSC's information systems resources were distributed to the operating divisions; the central information resources (IR) division controlled the remainder. A decentralization strategy was adopted in 1987. As Heschel put it, "When there's no synergy," he asked rhetorically, "why do it centrally?"

ASAP EXPRESS

Baxter Senior Vice President Richard B. Egen, who had been in charge of the merger integration team, noted that ASAP was one of the "major plusses" in Baxter's consideration

of AHSC. "There was probably a bit of the 'grass is greener' syndrome," Egen noted later, "and in fact Baxter already had TOPS, a fine system for entering and tracking orders taken over the telephone. But the merger allowed us to stop a $2 million project to make TOPS available to customers through terminals." In part to demonstrate that the two companies were really coming together, ASAP was linked to TOPS within four months of the merger, allowing customers to order Baxter products as well as those distributed by AHSC.

By 1986, AHSC's competitors had systems that were fully competitive with, and sometimes technically superior to ASAP. Utilization of ASAP had levelled off at about 55% of orders. Management changes, a conversion from Burroughs mainframes to IBM, and the relatively small size of the ASAP development staff had virtually stopped enhancements for about two years. Michael Hudson believed that 70-80% of orders was a reasonable goal for ASAP utilization. "ASAP saves Baxter about $11 million per year now by automating the customer service function," Hudson noted, "and there is another $4-$5 million available in realistic incremental savings through increased penetration and system utilization. In addition, there remains some product pull-through effect." A consulting study recommended adding some features to ASAP to meet or surpass the competition; creating one entity to be responsible for the system; encouraging use of the system by all divisions; and gathering additional information on system utilization. A second phase of the study resulted in the development of ASAP Express.

The consultants noted significant customer interest in all-vendor systems, which were considerably more convenient than separate systems with individual formats, passwords, and reports. Hospitals incurred nearly $2 in logistics costs for every $1 they spent on supplies. About 5% of the logistics costs were due to ordering itself, and an all-vendor system might reduce this directly by only 10%, but there was also significant value in the consolidated data that could be produced by an all-vendor system.

ASAP Express used the facilities of both Baxter and the General Electric Information Services Company (GEIS). The latter provided a worldwide telecommunications network and a clearinghouse that dispatched orders into electronic mailboxes that could be accessed only by the vendors to which they were assigned. ASAP Express would allow hospitals to enter, in ANSI X.12 format, orders for all participating vendors. Baxter orders would be handled through ASAP, while orders for other vendors would be passed to GEIS's electronic clearing house to be distributed to other participating vendors. Price and product availability information would be initially available only for items distributed by Baxter. Vendor-specific features, such as electronic catalogs, could be added to ASAP Express, and, as a result, vendors offering such features might achieve some advantage over their rivals.

ASAP market manager Sharon Hacker noted that ASAP Express could be an advantage to vendors who had not yet automated their order entry systems, or who had built customized systems that did not conform to the standard format used by ASAP Express. Although the first outside vendor actually using ASAP Express sold office supplies, two of Baxter's smaller competitors had asked to join the pilot project, and Baxter executives had held discussions with their counterparts at several very large health care supply companies. All of these potential participants in ASAP Express already had their own computerized order entry systems.

Security of data entered into ASAP Express was a concern for all participants, but especially for the other health care supply companies that were considering participation. Both Baxter and GEISCO had hired "Big Eight" public accounting firms to audit the integrity of ASAP Express, and both firms had issued positive reports. Customers and vendors alike could send in their own auditors on twenty-four hours' notice to examine the

security of the system. Passwords, authorizations, and audit trails formed an electronic security scheme, and data encryption was an available option. In the minds of many at Baxter, however, the real guarantee of data security was a legal environment and corporate culture that strongly discouraged the illicit use of data in any form. "We're not looking for lawsuits," Sharon Hacker said, while vice president Terry Mulligan noted, "We wouldn't look at anyone else's data--that would be stupid and a real job-loser around here."

Richard Egen believed that, for Baxter's hospital customers, the ultimate potential of ASAP Express was "the total automation of hospital logistics, virtually eliminating the clerical aspects of purchasing. This is very consistent with our total approach of creating a strong partnership relation with those hospital functions that have a major influence on supplies purchases. There will be fewer people in purchasing, but they will be more professional--all this software has to be managed by someone. Conceptually, how much more can you do with automated order entry beyond adding all vendors?"

There would, of course, be benefits for Baxter as well. Although pricing for ASAP Express had yet to be determined, there would be some revenue from participating vendors. Asked about vendors' potential concern about high transaction costs, Sharon Hacker said, "I can understand the fear of exorbitant rates, but we would not do that--our hospital customers wouldn't let us. Six or eight years from now we may make money on ASAP Express, but we designed the system as a service to our customers, not as a way to make money." Beyond the direct revenue, ASAP Express would bring Baxter additional control over the customer contact point. Of the 5,500 hospitals using ASAP, almost 3,500 accessed the system from a teletype or other terminal; competitors' systems were almost exclusively PC-based. "Customer recognition that computerized order entry can lower their costs is growing constantly," vice president Brien Laing noted. "More systems have been installed in the past four years than in the preceding ten. If somebody else gets their system into a hospital, it's two or three times as hard to get ours in as if we get there first." A third benefit of ASAP Express, thought by some at Baxter to be the most significant, came from additional product sales similar to those that had resulted from the installation of ASAP and other Baxter systems.

American Impact

Product "pull-through" had long been a goal, and an assumed outcome, of the installation of value-added systems from American Hospital Supply. In fact, analysis had consistently shown that hospitals with ASAP bought more items on each order, and more supplies per bed from American overall, than hospitals that did not use ASAP. There was always some question, however, about cause and effect: did hospitals order more because they had ASAP, or did they have ASAP because they ordered more?

As one method of combining the profit center style and the product pull-through focus, AHSC developed, and Baxter later adopted, the American Impact program. "Initially, our turn-key systems were sold or leased to hospitals. In 1986 we started an alternative financing program called Impact," Mike Hudson said. "This program allowed hospitals to pay for their information systems through increased purchases of Baxter supplies. The program has been very successful for Baxter and our customers." By making a three-year commitment for additional purchases from Baxter, hospitals who signed up for the Impact program were able to get, without charge, software and hardware costing as much as $200,000. "Prices for supplies purchased under the Impact program are the same as always," Paul Goldberg, director of systems and programming for Hospital services, noted. "The name of the game is incremental sales." Mike Hudson commented, "There is a tremendous need in the health care industry for systems--our customers are screaming for help. The real problem has been availability of funds. We show them opportunities; it's a real win/win situation." By mid-1987 more than 100 hospitals had used Impact to obtain

software and hardware, the latter including IBM and Texas Instrument minicomputers as well as personal computers. Although other health care suppliers had added software to their product lines by buying into software companies, hospitals liked both Baxter's products themselves and the fact that they gained additional leverage over the software supplier by virtue of their product purchases.

Ownership, Authority and Profits

Historically, American's Hospital Supply Division (HSD) had had its own information technology group, originally to do financial reporting and other relatively low-level tasks. Over time, ASAP and other value-added software became the responsibility of the Hospital Systems Division, which was established as a profit center with its own development and marketing resources. Paul Goldberg noted, "We run as a profit center not so much to make money as to keep from losing too much. Our real reason for being is to pull through product." Terry Mulligan agreed, saying, "We run Hospital Systems on a profit and loss basis to keep score; if it were only a cost center then we would get people inordinately tapping in. But it is not our expectation that the division will become a big business."

Paul Goldberg described what he saw as some of the pros and cons of having a separate group for development and support of systems like ASAP:

> My staff loves being close to the business. And I feel very strongly that the key is to have programmers, support people, salespeople, and so on acting like a small business that has a common goal. All of these people need the contact and the experience with customers. On the other hand, because my bosses have always been nontechnical, they could not necessarily tell if I was making technical mistakes. In ten years, I have never been asked about backups. If I were incompetent, we would be at tremendous risk. But if they ever called up my boss and told him they wanted to do a technical audit, I'd be delighted--I would come out looking very good.

Considering the organizational history of support for ASAP, Brien Laing commented,

> "There comes a time when, in order to gain attention, it is justifiable to keep things decentralized--for example, keeping ASAP out of the central IS group. I've started special divisions for supply products whose sales were way down, and the focused attention brought increases. ASAP had in fact suffered from a lack of attention, so perhaps it does deserve its separate division. But it was easier to have separate divisions when the industry was growing at a double-digit- rate. I led the charge to get ASAP taken over as a corporate function. Now I believe that the central IS group should take care of the technical aspects of ASAP, with marketing of the system done by a separate sales force. Moreover, I don't think the corporation should continue to charge the divisions for their customers' use of ASAP. In the pre-merger AHSC, we had such an elaborate cross-charging system that divisions were assessed for the use of the company auditorium. We need to be smart enough as a corporation to handle that sort of thing without hiring ten accountants."

Views from the Field

Laura Nozewski, the corporate systems manager for ASAP in New England, joined Baxter in January, 1987, after working in sales positions for Hershey and MCI. Nozewski was one of nine systems representatives hired to expand Hospital Systems' field sales force from 5 to 14. After receiving classroom training in ASAP, the new reps were assigned to locations around the country. Upon arriving in Boston, Nozewski found herself besieged with requests for ASAP support. "My predecessor, who was based in New Jersey, covered the five New England states plus Connecticut, Pennsylvania, New Jersey, and

New York," Nozewski said, "so she was stretched too thin to provide complete support. Customers can always call the hot line in Illinois, but sometimes they prefer to talk face to face."

Nozewski's responsibilities included the sale and installation of ASAP as well as training and support. In her first nine months with Baxter, she had worked with some 60 hospitals, dividing her time about equally between sales and service. "For hospitals that have no system," Nozewski said, "it's basically a concept sell. I promote the time and labor savings that ASAP can provide, along with flexibility in building orders, the ability to retrieve historical data, and the priority inventory position that ASAP orders receive. In hospitals that already have a competitor's system, I push ASAP features and capabilities--pricing and availability information, requisition lists, and customized order files and print-back formats. My first goal is to move business that's already being placed with Baxter to ASAP. Secondarily, I aim to get hospitals with ASAP to shift business to Baxter. The system is simple and friendly, and many hospitals just don't want to bother with another system." Nozewski used a list of hospitals in her region, showing the savings that Baxter would obtain if the hospital shifted all of its ordering to ASAP, to develop her sales plan. Nozewski noted that her customers were already asking about ASAP Express, even though the system had not been released. "Customers want standardization," she said, "and even some hospitals who are not large Baxter customers are interested in ASAP Express."

At Portsmouth Regional Hospital in Portsmouth, New Hampshire, materials manager Richard Pedrick oversaw the ordering of some $100,000 of supplies monthly. About 75% of these supplies were purchased from Baxter, 80% under a long-term contract that had been negotiated with Baxter by the Hospital Corporation of America (HCA), which had owned Portsmouth Regional since early 1984. The hospital had used ASAP for seven years, moving from punch cards to a Bell 43 terminal to an IBM AT. "As part of our contract with Baxter," Pedrick said, "they supply the computer equipment. But we could easily have justified the purchase of the gear on the basis of doing our job more quickly and efficiently. ASAP is worth whatever it takes to get it working. For one thing, the alternative of using the telephone is dreadful. But in a positive sense we have reduced invoice discrepancies and enjoy the flexibility that ASAP provides." Portsmouth had tried to use COACT, an electronic order entry system sold by Johnson & Johnson, but their volume of orders did not justify devoting much time to the system. "We were having some hardware problems a few weeks ago," Pedrick said, "and while trying to fix them we accidentally erased COACT from the AT's hard disk. It hasn't been worth it to put the software back on the disk."

At Emerson Hospital in Concord, a suburb of Boston, materials manager Coco Richmond was considering a move away from ASAP. Emerson was a member of the Voluntary Hospitals of America (VHA), a very large buying association of nonprofit hospitals. After an abortive attempt by American to merge with HCA, VHA had decided to form a supply company of its own, and had signed a contract with a competitor for its order entry and materials management systems. "Potentially," Richmond said, "this is the end of ASAP at Emerson. We would return the Bell 43 terminal and install a PC. But by now American has fine-tuned ASAP for us, for example by putting in our own item numbers to minimize the time spent on order entry. I want to be sure that I can get those features from a new system as well. Also, I refuse to regress to an exclusive system that would only let us order from one vendor. So although we have a group purchasing agreement through VHA for this other system, I will be looking at it quite carefully to be sure that it compares with ASAP." In mid-November 1987, Richmond and her staff met with representatives of the competitor's company. Richmond found that the alternative system duplicated some of ASAP, but was less informative and slower. She therefore decided to stay with the Baxter system for the immediate future.

"BEST ORIGINAL AVAILABLE"

Exhibit 1

Page from an ASAP Marketing Brochure

Build Orders Off-line at Your Convenience.

ASAP MICRO enables you to use your personal computer* to its fullest capabilities. Whether you want to create an order or part of an order, send a message, an inquiry, or review order status, you can do so at your convenience. You will save time and eliminate paper as orders and inquiries can be created off-line for later transmission. And, in many cases, you will have a head start as you can order using your item or reference numbers or by selecting items from your own data base. When you are ready, data can be sent at high speed in a matter of seconds over a telephone line. Confirmation information may be stored on a diskette for selective review and printing.

ASAP MICRO Will Pass Your Toughest Screen Test!

Microcomputer Order Entry:

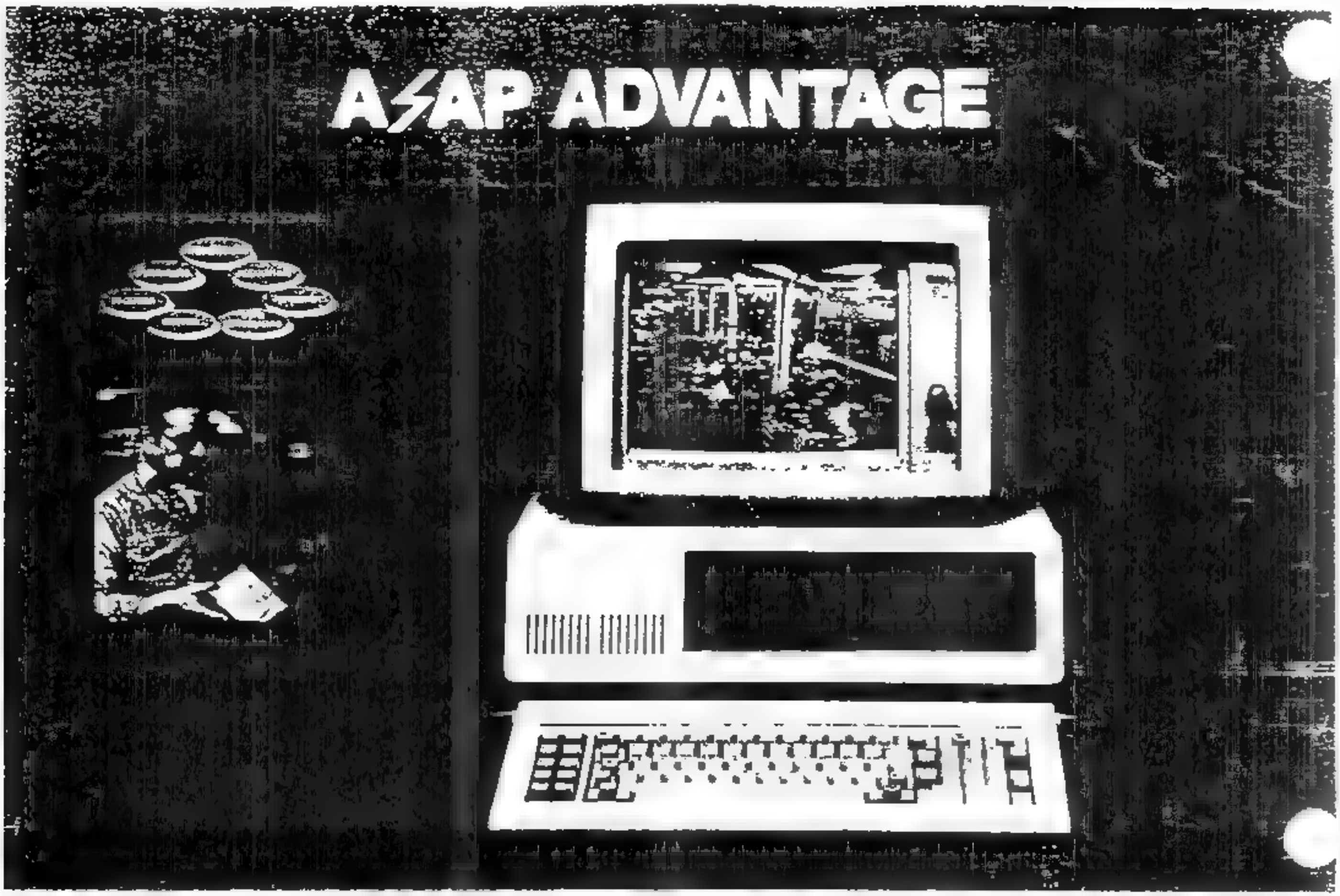
- **Reduces Order Preparation Time**—Now there is no need to start each order from scratch. Simply use the ASAP MICRO template and fill in the blanks. Placing orders is as easy as selecting the item you wish to purchase from your standing files. Or use your ASAP CUSTOM files to quickly place orders—your way.
- **Allows Orders to Be Built at Your Convenience**—With a personal computer and ASAP MICRO, you control and manage the sequence of events. You can create complete orders for immediate communication to your suppliers. Or, start an order, then add or change items whenever you wish prior to transmission.
- **Provides Selective Review/Printing Capabilities**—You can choose to review information just for critical needs or look at all available data. Then reduce paper handling by only printing what you require.
- **Enables You to Be Up and Running Quickly**—Although there is a comprehensive reference manual for ASAP MICRO, the system has been designed for ease in use. Our pull-down menu-driven software walks you through all ASAP functions. If you need help, it is available at your fingertips.
- **Provides "First Step" for Other Personal Computer Applications**—Once you have used ASAP MICRO, you will want to put your PC to use in other productive ways. You can be confident we are continuing to develop systems to meet your needs.

* [illegible] IBM [illegible]

"BEST ORIGINAL AVAILABLE"

Exhibit 2

ASAP Advantage Brochure



Today's Business Environment Software.

ASAP ADVANTAGE increases productivity and information while helping to control official/unofficial inventory expense

Provides the solution to the entire materials management chain of events

Sophisticated Software for All Vendor Purchasing and Inventory Management Systems.

- Interactive data base — items, vendors, departments, categories
- Stock/non stock purchasing and inventory management
- Expense, acquisition and revenue control of product distribution
- Automatic purchasing including electronic vendor interface
- Physical inventory
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Hard-to-beat Hardware. IBM PC/AT

Support You Can Count On.

- Features on-site implementation with comprehensive customer manuals that are supplemented by toll-free number "hot line" support

Exhibit 3

Page from a Hospital Systems Marketing Brochure

PICK A PECK OF PRODUCTS.

With Travenol's ASAP® Express — designed as the first all-vendor, all-transaction system for health care.

The Hospital Systems Division of Travenol Laboratories, Inc., the company that set the standards for computerized order entry, announces a major breakthrough in communications.

An all-vendor system.
ASAP® Express, the newest ASAP system, is designed to be the first all-vendor, all-transaction clearinghouse in the health care industry. Now you can say good-bye to multiple terminals. Format adaptations. And numerous phone calls.

ASAP Express is designed to enable you to conduct all your product purchasing business with all your vendors using one system. With one transaction. Anytime — day or night.

One format, one phone call.
Until now, different suppliers' purchasing systems were vendor specific, requiring multiple hardware or software, private networks, and different transaction formats. Now, with just one call to the ASAP Express "mailbox," you can quickly and easily send an order to any participating vendor and receive a timely confirmation. Standard ANSI formats make ASAP Express easy to use — simplicity that saves you time and money.

An all-transaction system.
Doing business with your vendors extends beyond purchasing and acknowledgment. So does ASAP Express. Inventory replenishment has never been simpler. With this one system, you can order both stock — and normally time-consuming non-stock items — with the same basic information.

ASAP Express also offers you electronic invoicing and payment capabilities that comply with the strictest audit requirements. By automating your financial activities, the system makes the final steps in the purchasing process as "paperless" as the initial ones. And again, your cost of doing business can be substantially lower.

Beyond materials management.
To make sure you'll be ready for the future in electronic transactions, Hospital Systems will continue to enhance this state-of-the-art system. For example, through messaging and access to standard and customized reports, ASAP Express will provide you with the information you need to monitor conformance with your purchasing policies. Whether you work in an individual institution or a multifacility system, ASAP Express strengthens your control over the everyday activities of your department.

Security and reliability.
ASAP Express offers you multiple levels of security to ensure confidentiality. And it's backed by Travenol's 18 years of experience in electronic data interchange (EDI) — the electronic transfer of information from one location to another.

For automation and innovation, turn to the leader you trust. And call your Hospital Systems representative today.

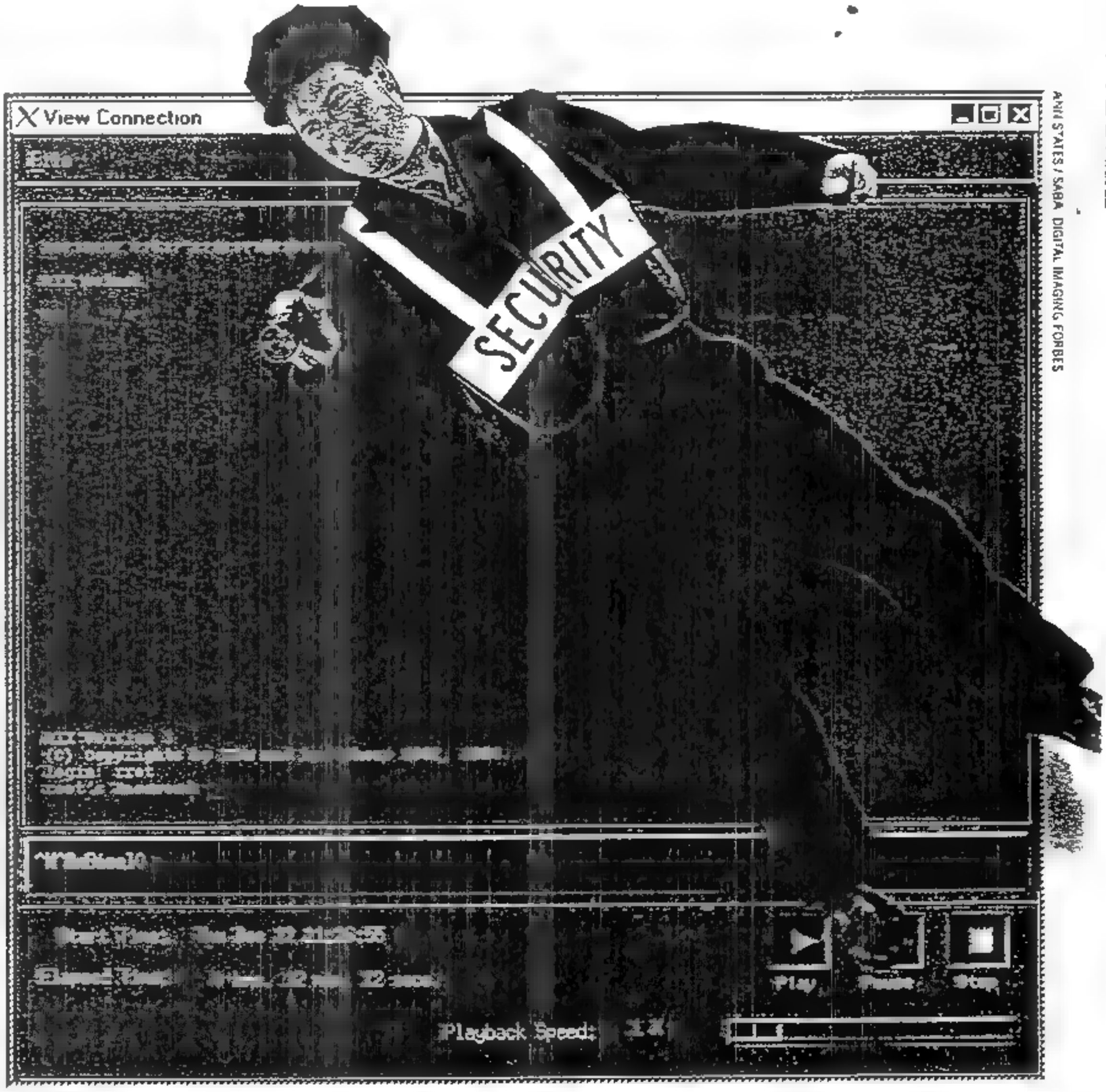
ASAP® *Express*
The one system to choose for all vendors you use

9

Do you need a security guard to protect your data? Consider hiring an experienced break-in artist.

Cybercops

By Zina Moukheiber



ANN STATES / SABA DIGITAL IMAGING FORBES

Internet Security Systems founder Chris Klaus **He wanted to beat the bad guys.**

IN WILLIAM GIBSON'S 1984 science fiction bestseller, *Neuromancer*, digirobbers break into the cyberspace matrix and steal precious data. Christopher Klaus was a ninth-grader at Sarasota (Fla.) High School when he read that book. He was captivated. Why not play data cops and robbers for real?

In the summer of 1990 Klaus was one of 50 high school students to win internships at Lawrence Livermore National Laboratories in Livermore, Calif. There, dabbling on supercomputers connected to the Internet, Klaus started to develop hacker counterattack weapons. The idea: Find the weak spots in a corporate or university network. Stage a test break-in. Then educate the victim about how to plug the holes in its defense.

Klaus enrolled at Georgia Tech. Then he did a Bill Gates, dropping out in his sophomore year to start a software firm. He wrote 50,000 lines of C programming code.

In the novel the good guys use a weapon called Intrusion Countermeasures Electronics. Klaus called his firm Internet Security Systems, with an acronym reminiscent of the sci-fi ICE. ISS is no Microsoft, not yet

anyway, but it's doing pretty well for a firm that is only three years old and is run by a 23-year-old. Based in Atlanta, ISS probably did at least $10 million in sales last year from its network security auditing and monitoring software. Its clients include Intel, J.C. Penney, Merck, U.S. Bancorp, the National Aeronautics & Space Administration and the Pentagon.

Joe Morris, a network security expert at Bell Atlantic, is an ISS fan. He once needed some of his colleagues' computer addresses when he was calling from out of town. While they were boasting about how great their security was, Morris used an ISS scanner to grab a confidential address file off their server. "It took five minutes; I said don't bother anymore, I already have the file," says Morris. His colleagues at Bell Atlantic became quite agitated.

How did the scanner sneak in? Through a back door that, in Unix servers, is all too often left unlocked: the so-called Trivial File Transfer Protocol. This protocol can allow anyone on a computer network or on the Internet to transfer files without having to use a password. Sounds hard to believe, but when the procedure was written in the 1970s, programmers didn't have hackers in mind. Solution: Turn off this protocol.

Klaus' scanning software has 200 other hacker tricks where this one came from. It also has a library of 25,000 words and names that are likely to be used as passwords. Thought you were being clever to use your dog's name as a password? "Spot" is on the list. So are "Steelers," "eagerbeaver" and "Startrek." You're supposed to select a string of gibberish characters as your password, of course. But all it takes in a 400-terminal network is one dimwit with an easy password, and the hacker can get in.

One of the easiest points of entry into a network is through E-mail. This is after cracking open a password, or in lieu of it. The ISS scanner identifies the E-mail server and then figures out what software it is running. If it's running Unix's Sendmail version 8.6.5, cracking open the mail server is almost as easy as booting up. A real hacker would use the mail server to read or delete E-mail, and even to break into other servers by installing a piece of software that captures passwords on the network.

The ISS program sends a warning flag. Scanning can take anywhere from five minutes to a month, depending on the number of computers and routers (network transfer points) being tested.

You thought you were protected by an Internet fire wall? You might be, you might not. "A fire wall is about as intelligent as a hammer," says Alan Witty, a senior manager in information security at KPMG Peat Marwick. "It is dependent on the people who put it in place."

"We complement fire walls," says Klaus. "We make sure all the windows are closed and the doors are locked."

In case the house gets too stuffy, you can relax the rules a bit and then use Internet Security Systems' monitoring software. It acts like a camera inside a network of up to 50 computers. The administrator can thus keep a log on all transactions and look for suspicious activity.

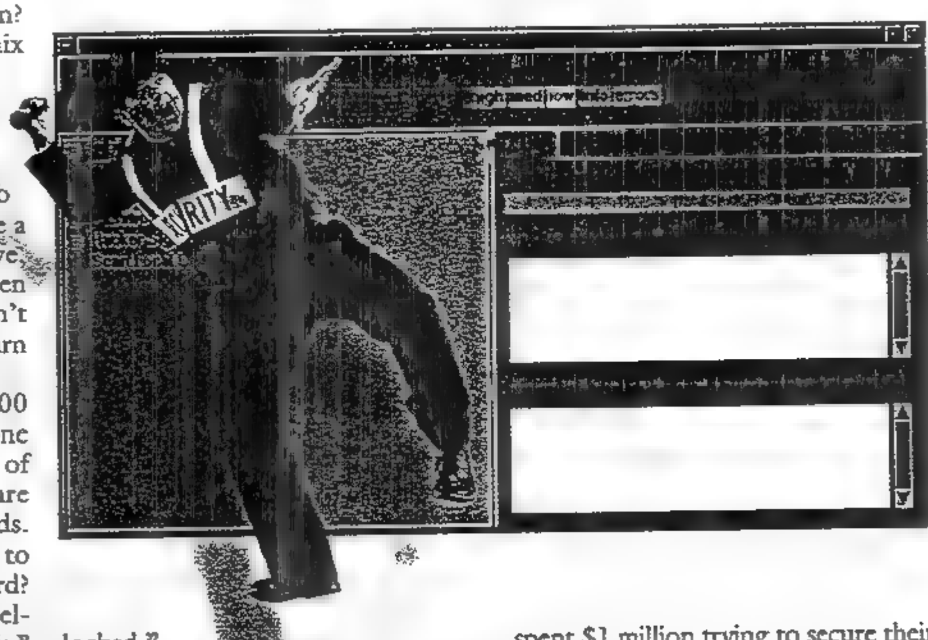
Novell was the first to license Klaus' scanner, for $20,000—a number Klaus picked out of thin air. "I didn't even know what an invoice was," he shrugs. "They didn't teach me that one at Georgia Tech." But he knew he needed a manager. He hired Thomas Noonan, now 36, a Georgia Tech graduate who was working at Dun & Bradstreet Software and was ready to trade in his Brooks Brothers suits. After two rounds of venture financing, the two of them still own just over half of ISS.

They made their first sales call together in 1995. NASA invited Klaus to lecture on security. Afterward a colonel ushered them into a computer room, where he asked to see a demo of Klaus' software. A few minutes into the demo an alarm went off. The scanner had broken into the classified Jet Propulsion Laboratory and pulled a bunch of passwords. "They'd spent $1 million trying to secure their computers," says Noonan, who grabbed his laptop to prepare a price list. Current prices: $10 to $80 per computer for the scanner, depending on how many computers are on your network. The monitor costs $5,000.

The 75 employees of ISS work hard to discover chinks in fire walls before the hackers do. The latest: A way to crack into a Windows NT server through port 135. Microsoft has scrambled to issue a corrective patch. If you are not sure whether your system administrator remembered to install the patch, better get a scanner. ■

ISS president Tom Noonan

His easiest sale: to a classified government lab, after the ISS scanner broke in and stole passwords.



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an Article from SCIENTIFIC AMERICAN

SEPTEMBER, 1991 VOL. 265 NO. 3

Computers, Networks and the Corporation

Computer networks are forging new kinds of markets and new ways to manage organizations. The result will be a major change in corporate structure and management style

by Thomas W. Malone and John F. Rockart

About 150 years ago the economy in the U.S. and Europe began to undergo a period of change more profound than any experienced since the end of the Middle Ages. We call that change the Industrial Revolution. The industrial economies are now in the early stages of another transformation that may ultimately be at least as significant.

There is a critical difference this time, however. Changes in the economies of production and transportation drove the revolution of the last century. The revolution under way today will be driven not by changes in production but by changes in coordination. Whenever people work together, they must somehow communicate, make decisions, allocate resources and get products and services to the right place at the right time. Managers, clerks, salespeople, buyers, brokers, accountants—in fact, almost everyone who works—must perform coordination activities.

It is in these heavily information-based activities that information technologies have some of their most important uses, and it is here that they will have their most profound effects.

THOMAS W. MALONE and JOHN F. ROCKART, both at the Massachusetts Institute of Technology, study the effects of computer technology on business. Malone, who directs the Center for Coordination Science at M.I.T., received his Ph.D. from Stanford University and holds degrees in applied mathematics, engineering and psychology. He was previously a research scientist at the Xerox Palo Alto Research Center. Rockart received his M.B.A. from Harvard University and his Ph.D. from M.I.T., where he directs the Center for Information Systems Research. He serves on the board of directors of five organizations and lectures at several major companies.

By dramatically reducing the costs of coordination and increasing its speed and quality, these new technologies will enable people to coordinate more effectively, to do much more coordination and to form new, coordination-intensive business structures.

The core of the new technologies is the networked computer. The very name "computer" suggests how one usually thinks of the device—as a machine for computing, that is, for taking in information, performing calculations and then presenting the results. But this image of computing does not capture the essence of how computers are used now and how they will be used even more in the future. Many of the most important uses of computers today are for coordination tasks, such as keeping track of orders, inventory and accounts. Furthermore, as computers become increasingly connected to one another, people will find many more ways to coordinate their work. In short, computers and computer networks may well be remembered not as technology used primarily to compute but as coordination technology.

To understand what is likely to happen as information technology improves and its costs decline, consider an analogy with a different technology: transportation. A first-order effect of transportation technology was simply the substitution of new transportation technologies for the old. People began to ride in trains and automobiles rather than on horses and in horse-drawn carriages.

As transportation technology continued to improve, people did not use it just to substitute for the transportation they had been using all along. Instead a second-order effect emerged: people began to travel more. They commuted farther to work each day. They were more likely to attend distant business meetings and to visit faraway friends and relatives.

Then, as people used more and more transportation, a third-order effect eventually occurred: the emergence of new "transportation-intensive" social and economic structures. These structures, such as suburbs and shopping malls, would not have been possible without the wide availability of cheap and convenient transportation.

Improved coordination technology has analogous effects. A first-ord[illegible] effect of reducing coordination co[illegible] the substitution of information tech[illegible]nology for human coordination. For example, data-processing systems helped to eliminate thousands of clerks from the back offices of insurance companies and banks. Similarly, computer-based systems have replaced scores of factory "expediters." Today computers track the priority of each job in the factory and indicate the most critical ones at each workstation. More generally, the long-standing prediction that computers will lead to the demise of middle management finally seems to be coming true. In the 1980s many companies flattened their managerial hierarchies by eliminating layers of middle managers.

A second-order effect of reducing coordination costs is an increase in the overall amount of coordination used. For instance, contemporary airline res-

TRADING FLOOR of the Paris Stock Exchange bustles with activity (*top*), much as do those of other exchanges. In contrast, the floor of the London International Stock Exchange, where trading is electronic, is quite leisured in pa[illegible] *tom*). The distinction reflects ho[illegible] works and coordination technology have begun to restructure the way businesses conduct transactions.

ervation systems enable travel agents to consider more flight possibilities for a given customer more easily. These systems have led to an explosion of special fares and price adjustments. American Airlines and United Air Lines, which provide the largest systems, have benefited significantly from the fees they charge for this service. For instance, in 1988 American made about $134 million from its reservation system—almost 15 percent of its total income. In addition, access to up-to-the-minute information about ticket sales on all airlines enables American and United to adjust their fare schedules to maximize profits.

Otis Elevator Company also increased the amount of its coordination—primarily to improve maintenance service for its customers. With its Otisline system, highly trained multilingual operators receive trouble calls through a national toll-free number. The operators record the problems in a computer data base and then electronically dispatch local repair people.

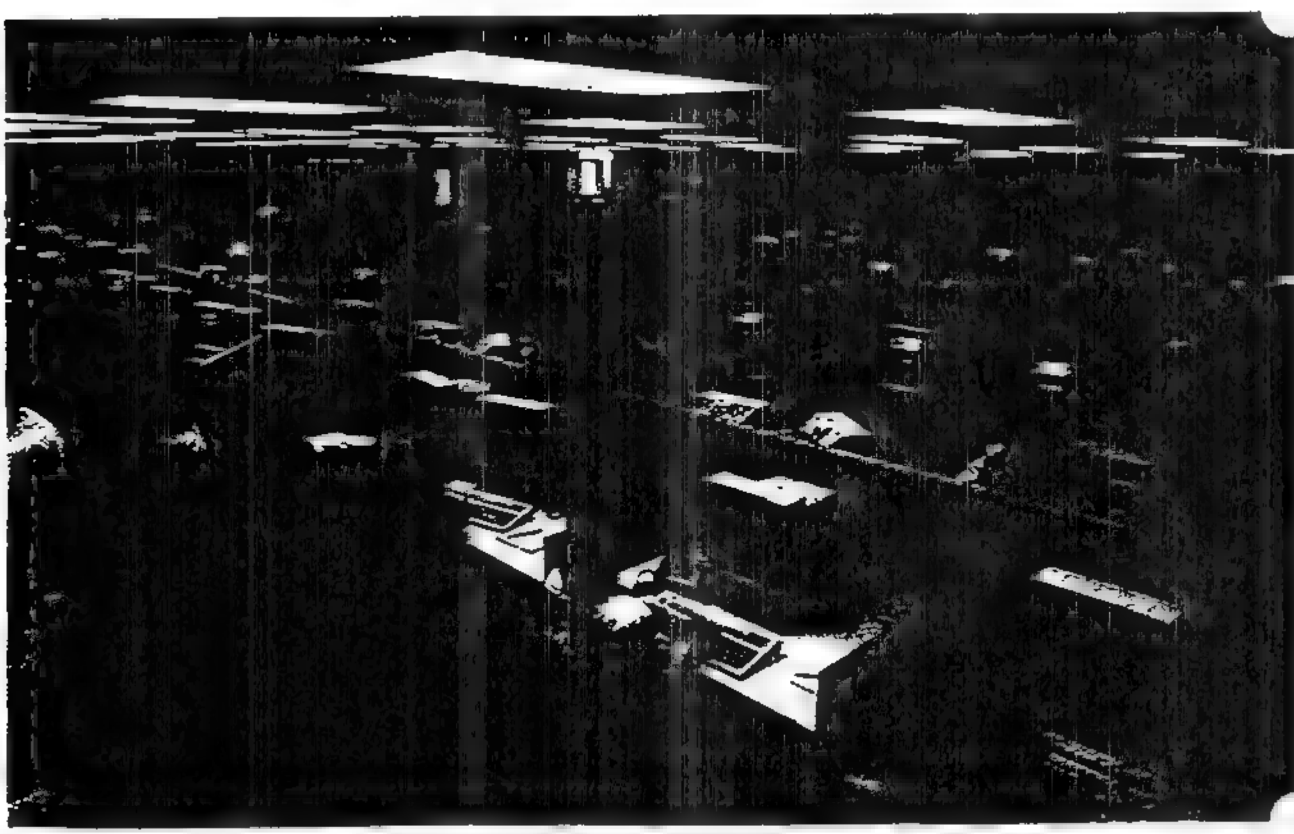
This real-time availability of data has vastly improved the management of repair activities. For instance, if a particular type of part has failed during the past week on eight of 100 elevators, Otis can preemptively replace that part on the other 92 elevators. Although this kind of nationwide correlation of data was possible before, the degree of communication and coordination required was impractical. These capabilities have played a major role in reducing maintenance calls by nearly 20 percent.

In some instances, the second-order effect of an increase in demand may overwhelm the first-order effect of substitution. For example, in one case we studied, a computer conferencing system helped to remove a layer of middle managers. Several years later, however, almost the same number of new positions (for different people at the same grade level) had been created. According to people in the company, the new specialists took on projects not considered before. Evidently, managerial resources no longer needed for simple communication could now be focused on more complex coordination tasks.

A third-order effect of reducing coordination costs is a shift toward the use of more coordination-intensive structures. A prime example is Frito-Lay, Inc., studied by Lynda M. Applegate of Harvard Business School and others. At Frito-Lay, some 10,000 route salespeople record all sales of each of 200 grocery products on hand-held computers as they deliver goods to customers on their route. Each night, the stored information is transmitted to a central computer. In turn, the central computer sends information on change pricing and product promotions to the hand-held computers for use the next day. Each week, the main computer summarizes the centrally stored information and combines it with external data about the sales of competitive brands. Some 40 senior executives and others can then gain access to this information through an executive information system (EIS).

The availability of these data has enabled Frito-Lay to push key decisions down from corporate headquarters to four area heads and several dozen district managers. The managers can use the data not only to compare actual sales to sales targets but also to recommend changes in sales strategy to top management. This entire coordination-intensive structure has become possible only in the past few years because of the improved capability and reduced costs of hand-held computers, EIS software, computer cycles and telecommunications equipment.

Coordination-intensive structures do not just link different people in the



RESERVATION CENTER of Rosenbluth Travel in Philadelphia transmits travel information to a "back room," which coordinates activities of other agencies from around the world. Information about demand becomes available immediately, enabling the connected firms to respond to the market more effectively and profitably than can isolated agencies.

same companies. Many of the most interesting new structures involve links among different companies. For example, the U.S. textile industry has begun implementing a series of electronic connections among companies as part of the Quick Response program. As described by Janice H. Hammond of Harvard Business School and others, these electronic connections link companies all along the production chain, from suppliers of fibers (such as wool and cotton) to the mills that weave these fibers into fabric, to the factories that sew garments and, ultimately, to the stores that sell the garments to consumers.

When such networks are fully implemented, they will help companies respond quickly to demand. For instance, when a sweater is sold in New York City, a scanner reading the bar-coded label may automatically trigger ordering, shipping and production activities all the way back to the wool warehouse in South Carolina. This new, multiorganizational structure will reduce inventory costs throughout the value chain. The textile-apparel retail industry spends about $25 billion in inventory costs every year; the Quick Response approach may save half that amount.

Wal-Mart has already established parts of a similar system that links the retailer to Procter & Gamble Company and several of its other major suppliers. In doing so, Wal-Mart has eliminated significant parts of its own purchasing groups and contracted with its suppliers to replace products as they are sold. In one such experiment, both unit sales and inventory turnover increased by about 30 percent.

Sometimes technology helps to create interorganizational networks—not just among buyers and suppliers but also among potential competitors. For example, Eric K. Clemons of the University of Pennsylvania has studied the Rosenbluth International Alliance, a consortium of travel agencies around the world that share customer records, services and software. The alliance also provides clients with toll-free English-language help lines in every major country. This consortium of independent agencies, led by Rosenbluth Travel in Philadelphia, can therefore manage all travel arrangements for international trips and for meetings of people from many parts of the globe.

The textile firms near Prato, Italy, illustrate a related kind of interoganizational alliance. As described by Michael J. Piore and Charles F. Sabel of the Massachusetts Institute of Technology, the operation of a few large textile mills was broken into many small firms, coordinated in part by electronic connections among them. This network can flexibly adjust to changes in demand, sometimes shifting orders from an overloaded mill to one with spare capacity. The structure also takes advantage of the entrepreneurial motivation of the owners: in small mills, the owners' rewards are more closely linked to their own efforts than is the case in large ones.

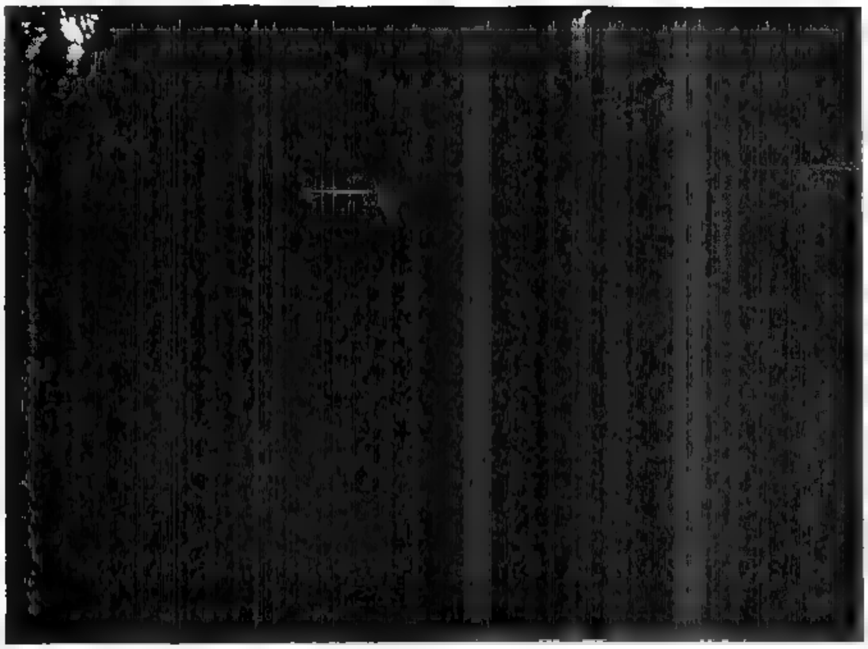
ROUTE SALESMAN of Frito-Lay, Inc., enters inventory data into a hand-held computer. The information will be combined with similar data from 10,000 other salespeople and made accessible to management the next morning. The rapid availability of data has enabled Frito-Lay to decentralize pricing and inventory decisions. Instead of corporate headquarters, four area heads and the district managers set prices, and the salespeople determine the product mix.

As these examples show, information technology is already facilitating the emergence of new, coordination-intensive structures. What do these changes mean for the organizations of the near future?

A surprising result of our research is a prediction that information technology should lead to an overall shift from internal decisions within firms toward the use of markets to coordinate economic activity. To see why, consider that all organizations must choose between making the goods or services they need and buying them from outside suppliers. For instance, General Motors Corporation must decide whether to make tires internally or purchase them from a tire manufacturer.

Each of these two forms of coordination—internal and external—has advantages and disadvantages. As Oliver Williamson of the University of California at Berkeley and others have argued, buying things from an outside supplier often requires more coordination than making them internally. To buy tires, General Motors may need to compare many potential suppliers, negotiate contracts and do formal accounting for the money that changes hands. Coordinating the production of tires internally, on the other hand, can often be done less formally and at lower cost, with telephone calls and meetings.

But improved information technology should reduce the costs of both internal and external coordination, much as transportation technology lowered the expense of traveling. When trains and automobiles reduced the difficulty of traveling, more people chose to live in the suburbs rather than in the cities to reap such benefits as extra living space. Similarly, when information technology reduces the costs of a given amount of coordination, companies will choose to buy more and make less. The additional coordination required in buying will no longer be as expensive, and buying has certain advantages. For instance, when General Motors buys tires, it can take advantage of the supplier's economies of scale and pick the best tires currently available from any supplier whenever its needs change. Thus, we expect networks to lead to less vertical integration—more buying



SCANNING OF BAR CODES is one component of the textile industry's Quick Response program. The scans provide information about the contents of a package to each member of the distribution chain, from supplier to retailer. The rapid transmission of data reduces inventory and enables the firms to adjust quickly to demand.

rather than making—and to the proliferation of smaller firms. More electronically mediated alliances (such as the Rosenbluth International Alliance) and an increased use of electronic markets to pick suppliers (such as the airline reservation system) will result.

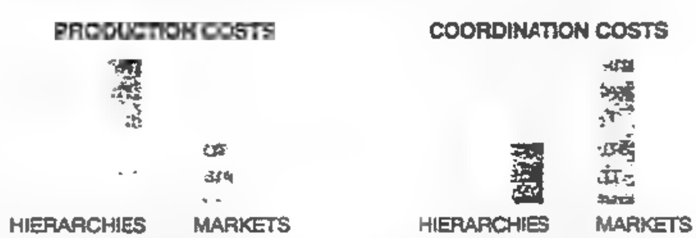
This argument implies that information technology will help make markets more efficient. Buyers will no longer have to exert great effort to compare products and prices from many different suppliers. Instead an electronic market can easily and inexpensively collect and distribute such information.

These more efficient markets threaten firms whose strategic advantages rest on market inefficiencies. For instance, as Clemons described, when the London International Stock Exchange installed an electronic trading system, the trading floor became virtually deserted within weeks. Trading moved to electronic terminals around the world. The system greatly reduced the costs of matching buyers and sellers. This change, in turn, dramatically reduced the profits of brokers and trading specialists, who previously had had a monopoly on performing this function. The potential decline in profit may explain why many other exchanges still resist electronic trading.

Many other kinds of intermediaries, such as distributors and retailers, are becoming vulnerable as well. For example, consumers can now bypass retail stores entirely by using computer-based systems such as Comp-U-C and Comp-u-store to buy househo goods and services at substantial savings. Electronic markets can also make evaluating product quality easier; we expect that it is only a matter of time before networks contain extensive comments and evaluations from previous buyers, becoming a kind of instantaneous, on-line *Consumer Reports*.

Increasing market efficiency also implies that firms should focus more carefully on the few core competencies that give them strategic advantages in the marketplace. They should buy the additional, more peripheral products and services they need instead of making them. For instance, in the past few years, Ford Motor Company and Chrysler Corporation have significantly increased their proportion of externally purchased components, such as tires and batteries.

Relative Costs for Hierarchies and Markets

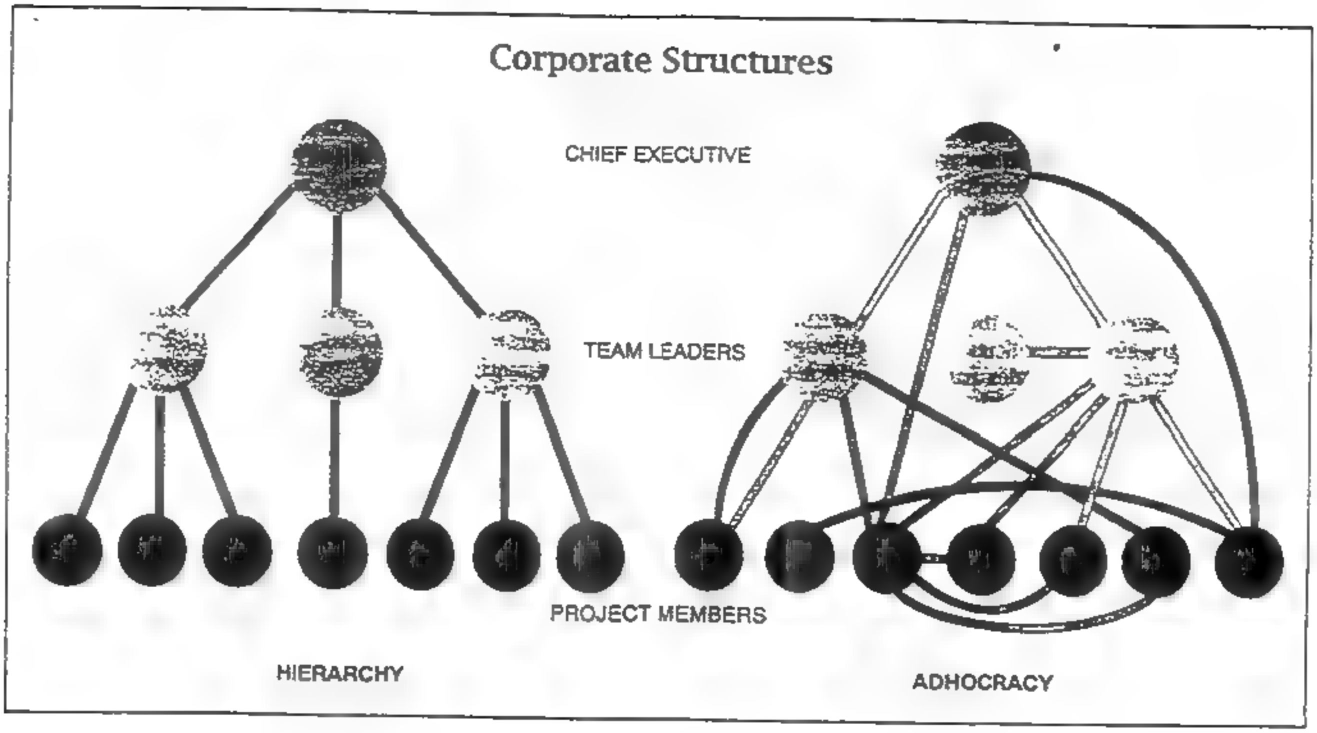


Making products in vertically integrated hierarchies usually involves higher production costs than buying them in the market. Buying from an outside supplier allows a company to exploit economies of scale and other production cost advantages. But buying usually requires higher coordination costs; a firm must find a supplier, negotiate contracts and account for payments.

Even though information technology can be strategically important, single innovations in information technology are seldom in themselves a source of continuing competitive advantage. For example, Ame can Hospital Supply (now Baxter Hea care Corporation) won high praise fo its early system that let customers place orders electronically without requiring a salesperson. This system made ordering from American Hospital easier than doing so from competitors and reduced the time salespeople had to spend on the clerical aspects of taking an order. But contrary to original expectations, systems like these do not "lock in" customers in the long run. Instead customers eventually seem to prefer electronic systems that provide a choice among several vendors. Similarly, an automatic teller machine system that may once have been a competitive advantage for a bank is now largely a competitive necessity.

One way to maintain an upper hand is to keep innovating so rapidly that other firms always lag a step behind. Another way, as Clemons has noted, is to use information technology to leverage some other structural advantage. For instance, Barclay deZoete Wedd, a British brokerage firm, continues to benefit from an electronic stock-trading system because the company already controlled the trading of far more stocks than did a of their competitors.

In addition to markets, another coordination-intensive organizational structure likely to become much more com-



mon is what some management theorists call a networked organization, or, more picturesquely, an "adhocracy," a term Alvin Toffler popularized in his book *Future Shock*. This form is already common in organizations such as law firms, consulting companies and research universities. Such organizations and institutions must continually readjust to a changing array of projects, each requiring a somewhat different combination of skills and other resources. These organizations depend on many rapidly shifting project teams and much lateral communication among these relatively autonomous, entrepreneurial groups.

The adhocracy contrasts with the conventional business organization of today: the hierarchy. Hierarchies are common partly because they provide a very economical way of coordinating large numbers of people. In principle, decision makers in a hierarchy can consider all the information known to anyone in the group with much less communication than would be needed if each person communicated with everyone else.

In practice, however, hierarchies have severe limitations. Central decision makers can become overloaded and therefore unable to cope effectively with rapidly changing environments or to consider enough information about complex issues. Furthermore, people at the bottom may feel left out of the decision making and as a result be less motivated to contribute their efforts.

As information technology reduces communication costs, the nonhierarchical structures (such as markets and adhocracies) may help overcome the limitations of hierarchies. For example, because of the large amount of unpredictable lateral communication, the adhocracy is extremely coordination intensive. New media, such as electronic mail, computer conferencing and electronic bulletin boards, can make the coordination easier and, therefore, enable the adhocracy to work much more effectively. Computer networks can help find and coordinate people with diverse knowledge and skills from many parts of an organization.

Moreover, computer-based technologies can transfer information not only faster and more cheaply but also more selectively. These capabilities help to mitigate information overload. Systems now exist to help people find, filter and sort their electronic mail based on topic, sender and other characteristics. Together these new coordination technologies can speed up the "information metabolism" of organizations—the rate at which firms can take in, move, digest and respond to data.

Abundant information poses two potential difficulties for organizational power. Some people worry that managers may become "Big Brothers" who use the information to exert stronger centralized control over those who work for them. Others fear that if power is decentralized throughout the organization, workers might use their newfound power to serve their own narrow interests, leading to organizational chaos.

In fact, neither dark vision has been realized. Instead what appears to be happening is a paradoxical combination of centralization and decentralization. Because information can be distributed more easily, people lower in the organization can now become well enough informed to make more decisions more effectively. At the same time, upper-level managers can more easily review decisions made at lower levels. Thus, because lower-level decision makers know they are subject to spot-checking, senior managers can retain or even increase their central control over decisions.

The changes at Phillips Petroleum Company illustrate this process. Previously, senior managers decided what price to set for petroleum products. These critical decisions depended on the recommendations of staff analysts several levels down. When Phillips Petroleum developed an executive information system, senior managers began to make some of these decisions more directly based on the global information provided by the system. The senior executives soon realized, however, that they could pass on this global information directly to local terminal managers, who could take into account information such as competitors' prices. By decentralizing the pricing decision in this way, the company made sounder, more profitable pricing strategies in each area of the country.

Another way of understanding this

paradoxical effect is to realize that new technology does not just redistribute power. It can provide a sense of more power for everyone. For example, the agents of several insurance companies currently carry laptop computers when they visit the homes of customers. The agents use the computers to fill out applications and to project premiums and benefits. But typically, underwriters at the corporate headquarters require several weeks to review the applications and to issue new policies.

Soon the underwriting rules for certain routine policies will be included in the laptop computer itself. The agent will be able to issue these policies immediately in the customers' homes.

These systems will thus "empower" the agents, who will control the time and place of the policy-acceptance decisions and can make sales immediately. The authority of the central underwriters will increase as well, because the rules they have created will be applied consistently. The underwriters will also be able to devote more time to analyzing interesting and potentially more profitable nonroutine cases.

Information technology not only changes power; it also changes time. On the one hand, time has expanded. Electronic mail, voice mail and facsimile transmissions can be sent or received at any time of day or night, almost anywhere around the globe. Similarly, customers of automatic teller machines and some stock markets can make transactions around the clock. The "work day" has much less meaning, and companies can compete by expanding the times their services are available.

On the other hand, time has contracted. Companies can also compete on speed. For instance, effective coordination can reduce the time needed to develop new products, deliver orders or react to customer requests. Management teams, such as the one at Phillips Petroleum, have information available throughout the management hierarchy, which enables them to react to market conditions much more quickly. Decisions that might have taken days in the past can now be made within hours or minutes.

The changes discussed so far require no great predictive leaps; they are already happening. What will happen as information technology improves even more? What other kinds of organizations might emerge in the globally interconnected world that the technologies make feasible?

One possibility is the increasing importance of "answer networks," networks of experts available to answer questions in different areas. One might go to these services with questions such as "How many bars of soap were sold in Guatemala last year?" or "What are the prospects of room-temperature superconductivity in consumer products by 1995?" The services would include massive data bases and layers of human experts in many different topic areas. Some questions will be easily answerable from information in a data base. Others will be referred to progressively more knowledgeable human experts. Depending on how much is willing to spend and how quickly wants the answer, the response might range from a newspaper clipping to a personal reply from a Nobel laureate scientist. Similar but limited services exist today—product hot lines and library reference desks are examples—but computer networks and data bases will make such services much less expensive, much more valuable and, therefore, much more widely used.

Electronically mediated markets can also assemble armies of "intellectual mercenaries" virtually overnight. For instance, there may be a large number of consultants who make their living doing short-term projects over the network. If a manager has a job to be done, such as evaluating a loan or designing a lawnmower, he or she could quickly assemble a team by advertising electronically or by consulting a data base of available people. The data base might contain not only the skills and billing rates of prospective workers but also unedited comments from others who had used their services before. Although consulting firms and advertising agencies sometimes work l this now, pervasive networks will al teams to be assembled much more quickly, for shorter projects and from many different organizations.

This kind of market for services might be used inside an organization as well. Instead of always relying on supervisors to allocate the time of people who work for them, extensive internal markets for the services of people and groups may exist. Murray Turoff of the New Jersey Institute of Technology has suggested how such a system might work. Someone with a short programming project to be done, for instance, might advertise internally for a programmer. Bids and payments for this internal market could be in real dollars or some kind of point system. The bids from programmers would indicate their skill and availability. The payments that programmers receive would reflect how valuable they had been to other parts of the organization.

Improved technology can also help create decision-making structures that integrate qualitative input from many people. For instance, in making complex decisions, such as where to locate a new plant, the amassing of m facts and opinions is critical. To companies often make such decisions after incomplete discussions with only a few of the people whose knowledge

AUTOMATIC TELLER MACHINES, once a novelty, are now largely a competitive necessity; single innovations in information technology seldom provide long-term advantages. To remain competitive, firms must keep innovating to stay a step ahead or use existing technology to enhance some other advantage.

SUBURBS represent a third-order effect of improved transportation technology: with cheap and convenient transportation came "transportation-intensive" structures. Their existence, however, also depended on the American values placed on the importance of home ownership and the moral superiority of rural life. Similarly, the kinds of coordination-intensive structures that will emerge when information becomes freely accessible will depend on the values society finds important. Will the ideals that shaped Boca Raton, Fla., also play a role in future corporate structures?

or point of view might be valuable. In the future, companies may use computer networks to organize and record the issues, alternatives, arguments and counterarguments in graphical form. Then many different people can review and critique the parts of the argument about which they know or care.

For instance, someone in a remote part of the firm might know about plans for a new highway that completely change the desirability of a proposed plant location. As such information accumulates, people can vote on the plausibility of different claims. Then, using all the information displayed in the system, a single person or group can ultimately make the decision.

What will happen as the globally networked society leads to a world in which vast amounts of information are freely available or easily purchased? Clearly, this world will require services, both automated and human, to filter the tremendous amount of information available. In general, as the amount of information increases, people who can creatively analyze, edit and act on information in ways that cannot be automated will become even more valuable.

But what else people will do will depend on the values that are important to them. When trains and automobiles reduced the constraints of travel time, other values became more significant in determining working and living patterns. As Kenneth T. Jackson of Columbia University has documented, for example, American values about the importance of owning one's home and the moral superiority of rural life played a large role in determining the nature of suburbs in the U.S.

Similarly, when the costs of information and coordination are not a barrier to fulfilling people's needs and wants, other values may emerge to shape the workplace and society. The new information technologies will almost certainly help gratify some obvious wants, such as the desire for money. Some of the emerging corporate structures may be especially good at satisfying nonmaterial needs, such as those for challenge and autonomy.

But perhaps these desires are themselves manifestations of some still deeper needs. Psychologists sometimes refer to a need for self-actualization. Others might call this a desire for spiritual fulfillment. To use the new technologies wisely, we will need to think more carefully about what we truly value and how the technology can help us reach our deeper goals.

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THE COMING OF THE NEW ORGANIZATION

by PETER F. DRUCKER

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THE COMING OF THE NEW ORGANIZATION

by PETER F. DRUCKER

The typical large business 20 years hence will have fewer than half the levels of management of its counterpart today, and no more than a third the managers. In its structure, and in its management problems and concerns, it will bear little resemblance to the typical manufacturing company, circa 1950, which our textbooks still consider the norm. Instead it is far more likely to resemble organizations that neither the practicing manager nor the management scholar pays much attention to today: the hospital, the university, the symphony orchestra. For like them, the typical business will be knowledge-based, an organization composed largely of specialists who direct and discipline their own performance through organized feedback from colleagues, customers, and headquarters. For this reason, it will be what I call an information-based organization.

Businesses, especially large ones, have little choice but to become information-based. Demographics, for one, demands the shift. The center of gravity in employment is moving fast from manual and clerical workers to knowledge workers who resist the command-and-control model that business took from the military 100 years ago. Economics also dictates change, especially the need for large businesses to innovate and to be entrepreneurs. But above all, information technology demands the shift.

The large business 20 years hence is more likely to resemble a hospital or a symphony than a typical manufacturing company.

Advanced data-processing technology isn't necessary to create an information-based organization, of course. As we shall see, the British built just such an organization in India when "information technology" meant the quill pen, and barefoot runners were the "telecommunications" systems. But as advanced technology becomes more and more prevalent, we have to engage in analysis and

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diagnosis—that is, in "information"—even more intensively or risk being swamped by the data we generate.

So far most computer users still use the new technology only to do faster what they have always done before, crunch conventional numbers. But as soon as a company takes the first tentative steps from data to information, its decision processes, management structure, and even the way its work gets done begin to be transformed. In fact, this is already happening, quite fast, in a number of companies throughout the world.

We can readily see the first step in this transformation process when we consider the impact of computer technology on capital-investment decisions. We have known for a long time that there is no one right way to analyze a proposed capital investment. To understand it we need at least six analyses: the expected rate of return; the payout period and the investment's expected productive life; the discounted present value of all returns through the productive lifetime of the investment; the risk in not making the investment or deferring it; the cost and risk in case of failure; and finally, the opportunity cost. Every accounting student is taught these concepts. But before the advent of data-processing capacity, the actual analyses would have taken man-years of clerical toil to complete. Now anyone with a spreadsheet should be able to do them in a few hours.

The availability of this information transforms the capital-investment analysis from opinion into diagnosis, that is, into the rational weighing of alternative assumptions. Then the information transforms the capital-investment decision from an opportunistic, financial decision governed by the numbers into a business decision based on the probability of alternative strategic assumptions. So the decision both presupposes a business strategy and challenges that strategy and its assumptions. What was once a budget exercise becomes an analysis of policy.

Information transforms a budget exercise into an analysis of policy.

The second area that is affected when a company focuses its data-processing capacity on producing information is its organization structure. Almost immediately, it becomes clear that both the number of management levels and the number of managers can be sharply cut. The reason is straightforward: it turns out that whole layers of management neither make decisions nor lead. Instead, their main, if not their only, function is to serve as "relays"—human boosters for the faint, unfocused signals that pass for communication in the traditional pre-information organization.

One of America's largest defense contractors made this discovery when it asked what information its top corporate and operating managers needed to do their jobs. Where did it come from? What form was it in? How did it flow? The search for answers soon revealed that whole layers of management—perhaps as many as 6 out of a total of 14—existed only because these questions had not been asked before. The company had had data galore. But it had always used its copious data for control rather than for information.

Information is data endowed with relevance and purpose. Converting data into information thus requires knowledge. And knowledge, by definition, is specialized. (In fact, truly knowledgeable people tend toward overspecialization, whatever their field, precisely because there is always so much more to know.)

The information-based organization requires far more specialists overall than the command-and-control companies we are accustomed to. Moreover, the specialists are found in operations, not at corporate headquarters. Indeed, the operating organization tends to become an organization of specialists of all kinds.

Information-based organizations need central operating work such as legal counsel, public relations, and labor relations as much as ever. But the need for service staffs—that is, for people without operating responsibilities who only advise, counsel, or coordinate—shrinks drastically. In its *central* management, the information-based organization needs few, if any, specialists.

Traditional departments won't be where the work gets done.

Because of its flatter structure, the large, information-based organization will more closely resemble the businesses of a century ago than today's big companies. Back then, however, all the knowledge, such as it was, lay with the very top people. The rest were helpers or hands, who mostly did the same work and did as they were told. In the information-based organization, the knowledge will be primarily at the bottom, in the minds of the specialists who do different work and direct themselves. So today's typical organization in which knowledge tends to be concentrated in service staffs, perched rather insecurely between top management and the operating people, will likely be labeled a phase, an attempt to infuse knowledge from the top rather than obtain information from below.

Finally, a good deal of work will be done differently in the information-based organization. Traditional departments will serve as guardians of standards, as centers for training and the assignment of specialists; they won't be where the work gets done. That will happen largely in task-focused teams.

This change is already under way in what used to be the most clearly defined of all departments—research. In pharmaceuticals, in telecommunications, in papermaking, the traditional *sequence* of research, development, manufacturing, and marketing is being replaced by *synchrony*: specialists from all these functions work together as a team, from the inception of research to a product's establishment in the market.

How task forces will develop to tackle other business opportunities and problems remains to be seen. I suspect, however, that the need for a task force, its assignment, its composition, and its leadership will have to be decided on case by case. So the organization that will be developed will go beyond the matrix and may indeed be quite different from it. One thing is clear, though: it will require greater self-discipline and even greater emphasis on individual responsibility for relationships and for communications.

To say that information technology is transforming business enterprises is simple. What this transformation will require of companies and top managements is much harder to decipher. That is why I find it helpful to look for clues in other kinds of information-based organizations, such as the hospital, the symphony orchestra, and the British administration in India.

A fair-sized hospital of about 400 beds will have a staff of several hundred physicians and 1,200 to 1,500 paramedics divided among some 60 medical and paramedical specialities. Each specialty has its own knowledge, its own training, its own languge. In each specialty, especially the paramedical ones like the clinical lab and physical

therapy, there is a head person who is a working specialist rather than a full-time manager. The head of each specialty reports directly to the top, and there is little middle management. A good deal of the work is done in ad hoc teams as required by an individual patient's diagnosis and condition.

A large symphony orchestra is even more instructive, since for some works there may be a few hundred musicians on stage playing together. According to organization theory then, there should be several group vice president conductors and perhaps a half-dozen division VP conductors. But that's not how it works. There is only the conductor-CEO–and every one of the musicians plays directly to that person without an intermediary. And each is a high-grade specialist, indeed an artist.

But the best example of a large and successful information-based organization, and one without any middle management at all, is the British civil administration in India.[1]

The best example of a large and successful information-based organization had no middle management at all.

The British ran the Indian subcontinent for 200 years, from the middle of the eighteenth century through World War II, without making any fundamental changes in organization structure or administrative policy. The Indian civil service never had more than 1,000 members to administer the vast and densely populated subcontinent–a tiny fraction (at most 1%) of the legions of Confucian mandarins and palace eunuchs employed next door to administer a not-much-more populous China. Most of the Britishers were quite young; a 30-year-old was a survivor, especially in the early years. Most lived alone in isolated outposts with the nearest countryman a day or two of travel away, and for the first hundred years there was no telegraph or railroad.

The organization structure was totally flat. Each district officer reported directly to the "Coo," the provincial political secretary. And since there were nine provinces, each political secretary had at least 100 people reporting directly to him, many times what the doctrine of the span of control would allow. Nevertheless, the system worked remarkably well, in large part because it was designed to ensure that each of its members had the information he needed to do his job.

Each month the district officer spent a whole day writing a full report to the political secretary in the provincial capital. He discussed each of his principal tasks–there were only four, each clearly delineated. He put down in detail what he had expected would happen with respect to each of them, what actually did happen, and why, if there was a discrepancy, the two differed. Then he wrote down what he expected would happen in the ensuing month with respect to each key task and what he was going to do about it, asked questions about policy, and commented on long-term opportunities, threats, and needs. In turn, the political secretary "minuted" every one of those reports–that is, he wrote back a full comment.

1. The standard account is Philip Woodruff, *The Men Who Ruled India*, especially the first volume, *The Founders of Modern India* (New York: St. Martin's, 1954). How the system worked day by day is charmingly told in *Sowing* (New York: Harcourt Brace Jovanovich, 1962), volume one of the autobiography of Leonard Woolf (Virginia Woolf's husband).

On the basis of these examples, what can we say about the requirements of the information-based organization? And what are its management problems likely to be? Let's look first at the requirements. Several hundred musicians and their CEO, the conductor, can play together because they all have the same score. It tells both flutist and timpanist what to play and when. And it tells the conductor what to expect from each and when. Similarly, all the specialists in the hospital share a common mission: the care and cure of the sick. The diagnosis is their "score"; it dictates specific action for the X-ray lab, the dietitian, the physical therapist, and the rest of the medical team.

Information-based organizations, in other words, require clear, simple, common objectives that translate into particular actions. At the same time, however, as these examples indicate, information-based organizations also need concentration on one objective or, at most, on a few.

Because the "players" in an information-based organization are specialists, they cannot be told how to do their work. There are probably few orchestra conductors who could coax even one note out of a French horn, let alone show the horn player how to do it. But the conductor can focus the horn player's skill and knowledge on the musicians' joint performance. And this focus is what the leaders of an information-based business must be able to achieve.

Yet a business has no "score" to play by except the score it writes as it plays. And whereas neither a first-rate performance of a symphony nor a miserable one will change what the composer wrote, the performance of a business continually creates new and different scores against which its performance is assessed. So an information-based business must be structured around goals that clearly state management's performance expectations for the enterprise and for each part and specialist and around organized feedback that compares results with these performance expectations so that every member can exercise self-control.

The other requirement of an information-based organization is that everyone take information responsibility. The bassoonist in the orchestra does so every time she plays a note. Doctors and paramedics work with an elaborate system of reports and an information center, the nurse's station on the patient's floor. The district officer in India acted on this responsibility every time he filed a report.

Who depends on me for information? And on whom do I depend?

The key to such a system is that everyone asks: Who in this organization depends on me for what information? And on whom, in turn, do I depend? Each person's list will always include superiors and subordinates. But the most important names on it will be those of colleagues, people with whom one's primary relationship is coordination. The relationship of the internist, the surgeon, and the anesthesiologist is one example. But the relationship of a biochemist, a pharmacologist, the medical director in charge of clinical testing, and a marketing specialist in a pharmaceutical company is no different. It, too, requires each party to take the fullest information responsibility.

Information responsibility to others is increasingly understood, especially in middle-sized companies. But information responsibility to oneself is still largely neglected. That is, everyone in an organization should constantly be thinking through what information he or she needs to do the job and to make a contribution.

This may well be the most radical break with the way even the most highly computerized businesses are still being run today. There, people either assume the more data, the more information—which was a perfectly valid assumption yesterday when data were scarce, but leads to data overload and information blackout now that they are plentiful. Or they believe that information specialists know what data executives and professionals need in order to have information. But information specialists are tool makers. They can tell us what tool to use to hammer upholstery nails into a chair. We need to decide whether we should be upholstering a chair at all.

Executives and professional specialists need to think through what information is for them, what data they need: first, to know what they are doing; then, to be able to decide what they should be doing; and finally, to appraise how well they are doing. Until this happens MIS departments are likely to remain cost centers rather than become the result centers they could be.

Most large businesses have little in common with the examples we have been looking at. Yet to remain competitive—maybe even to survive—they will have to convert themselves into information-based organizations, and fairly quickly. They will have to change old habits and acquire new ones. And the more successful a company has been, the more difficult and painful this process is apt to be. It will threaten the jobs, status, and opportunities of a good many people in the organization, especially the long-serving, middle-aged people in middle management who tend to be the least mobile and to feel most secure in their work, their positions, their relationships, and their behavior.

To remain npetitive—maybe even to survive—sinesses will have ɔnvert themselves into organizations of knowledgeable specialists.

The information-based organization will also pose its own special management problems. I see as particularly critical:

1. Developing rewards, recognition, and career opportunities for specialists.

2. Creating unified vision in an organization of specialists.

3. Devising the management structure for an organization of task forces.

4. Ensuring the supply, preparation, and testing of top management people.

Bassoonists presumably neither want nor expect to be anything but bassoonists. Their career opportunities consist of moving from second bassoon to first bassoon and perhaps of moving from a second-rank orchestra to a better, more prestigious one. Similarly, many medical technologists neither expect nor want to be anything but medical technologists. Their career opportunities consist of a fairly good chance of moving up to senior technician, and a very slim chance of becoming lab director. For those who make it to lab director, about 1 out of every 25 or 30 technicians, there is also the opportunity to move to a bigger, richer hospital. The district officer in India had practically no chance for professional growth except possibly to be relocated, after a three-year stint, to a bigger district.

Opportunities for specialists in an information-based business organization should be more plentiful than they are in an orchestra or hospital, let alone in the Indian civil service. But as in these organizations, they will primarily be opportunities for advancement

within the specialty, and for limited advancement at that. Advancement into "management" will be the exception, for the simple reason that there will be far fewer middle-management positions to move into. This contrasts sharply with the traditional organization where, except in the research lab, the main line of advancement in rank is out of the specialty and into general management.

More than 30 years ago General Electric tackled this problem by creating "parallel opportunities" for "individual professional contributors." Many companies have followed this example. But professional specialists themselves have largely rejected it as a solution. To them—and to their management colleagues—the only meaningful opportunities are promotions into management. And the prevailing compensation structure in practically all businesses reinforces this attitude because it is heavily biased towards managerial positions and titles.

Who will the business's managers be?

There are no easy answers to this problem. Some help may come from looking at large law and consulting firms, where even the most senior partners tend to be specialists, and associates who will not make partner are outplaced fairly early on. But whatever scheme is eventually developed will work only if the values and compensation structure of business are drastically changed.

The second challenge that management faces is giving its organization of specialists a common vision, a view of the whole.

In the Indian civil service, the district officer was expected to see the "whole" of his district. But to enable him to concentrate on it, the government services that arose one after the other in the nineteenth century (forestry, irrigation, the archaeological survey, public health and sanitation, roads) were organized outside the administrative structure, and had virtually no contact with the district officer. This meant that the district officer became increasingly isolated from the activities that often had the greatest impact on—and the greatest importance for—his district. In the end, only the provincial government or the central government in Delhi had a view of the "whole," and it was an increasingly abstract one at that.

A business simply cannot function this way. It needs a view of the whole and a focus on the whole to be shared among a great many of its professional specialists, certainly among the senior ones. And yet it will have to accept, indeed will have to foster, the pride and professionalism of its specialists—if only because, in the absence of opportunities to move into middle management, their motivation must come from that pride and professionalism.

One way to foster professionalism, of course, is through assignments to task forces. And the information-based business will use more and more smaller self-governing units, assigning them tasks tidy enough for "a good man to get his arms around," as the old phrase has it. But to what extent should information-based businesses rotate performing specialists out of their specialties and into new ones? And to what extent will top management have to accept as its top priority making and maintaining a common vision across professional specialties?

Heavy reliance on task-force teams assuages one problem. But it aggravates another: the management structure of the information-based organization. Who will the business's managers be? Will they be task-force leaders? Or will there be a two-headed monster—a specialist structure, comparable, perhaps, to the way attending physi-

cians function in a hospital, and an administrative structure of task-force leaders?

The decisions we face on the role and function of the task-force leaders are risky and controversial. Is theirs a permanent assignment, analagous to the job of the supervisory nurse in the hospital? Or is it a function of the task that changes as the task does? Is it an assignment or a position? Does it carry any rank at all? And if it does, will the task-force leaders become in time what the product managers have been at Procter & Gamble: the basic units of management and the company's field officers? Might the task-force leaders eventually replace department heads and vice presidents?

Signs of every one of these developments exist, but there is neither a clear trend nor much understanding as to what each entails. Yet each would give rise to a different organizational structure from any we are familiar with.

With middle management sharply cut, where will the top executives come from?

Finally, the toughest problem will probably be to ensure the supply, preparation, and testing of top management people. This is, of course, an old and central dilemma as well as a major reason for the general acceptance of decentralization in large businesses in the last 40 years. But the existing business organization has a great many middle-management positions that are supposed to prepare and test a person. As a result, there are usually a good many people to choose from when filling a senior management slot. With the number of middle-management positions sharply cut, where will the information-based organization's top executives come from? What will be their preparation? How will they have been tested?

Decentralization into autonomous units will surely be even more critical than it is now. Perhaps we will even copy the German *Gruppe* in which the decentralized units are set up as separate companies with their own top managements. The Germans use this model precisely because of their tradition of promoting people in their specialties, especially in research and engineering; if they did not have available commands in near-independent subsidiaries to put people in, they would have little opportunity to train and test their most promising professionals. These subsidiaries are thus somewhat like the farm teams of a major-league baseball club.

We may also find that more and more top management jobs in big companies are filled by hiring people away from smaller companies. This is the way that major orchestras get their conductors—a young conductor earns his or her spurs in a small orchestra or opera house, only to be hired away by a larger one. And the heads of a good many large hospitals have had similar careers.

Can business follow the example of the orchestra and hospital where top management has become a separate career? Conductors and hospital administrators come out of courses in conducting or schools of hospital administration respectively. We see something of this sort in France, where large companies are often run by men who have spent their entire previous careers in government service. But in most countries this would be unacceptable to the organization (only France has the *mystique* of the *grandes écoles*). And even in France, businesses, especially large ones, are becoming too demanding to be run by people without firsthand experience and a proven success record.

Thus the entire top management process—preparation, testing, succession—will become even more problematic than it already is.

There will be a growing need for experienced businesspeople to go back to school. And business schools will surely need to work out what successful professional specialists must know to prepare themselves for high-level positions as *business* executives and *business* leaders.

Since modern business enterprise first arose, after the Civil War in the United States and the Franco-Prussian War in Europe, there have been two major evolutions in the concept and structure of organizations. The first took place in the ten years between 1895 and 1905. It distinguished management from ownership and established management as work and task in its own right. This happened first in Germany, when Georg Siemens, the founder and head of Germany's premier bank, *Deutsche Bank*, saved the electrical apparatus company his cousin Werner had founded after Werner's sons and heirs had mismanaged it into near collapse. By threatening to cut off the bank's loans, he forced his cousins to turn the company's management over to professionals. A little later, J.P. Morgan, Andrew Carnegie, and John D. Rockefeller, Sr. followed suit in their massive restructurings of U.S. railroads and industries.

The second evolutionary change took place 20 years later. The development of what we still see as the modern corporation began with Pierre S. du Pont's restructuring of his family company in the early twenties and continued with Alfred P. Sloan's redesign of General Motors a few years later. This introduced the command-and-control organization of today, with its emphasis on decentralization, central service staffs, personnel management, the whole apparatus of budgets and controls, and the important distinction between policy and operations. This stage culminated in the massive reorganization of General Electric in the early 1950s, an action that perfected the model most big businesses around the world (including Japanese organizations) still follow.[2]

We can identify requirements and point to proble[ms] the job of building still ahead.

Now we are entering a third period of change: the shift from the command-and-control organization, the organization of departments and divisions, to the information-based organization, the organization of knowledge specialists. We can perceive, though perhaps only dimly, what this organization will look like. We can identify some of its main characteristics and requirements. We can point to central problems of values, structure, and behavior. But the job of actually building the information-based organization is still ahead of us—it is the managerial challenge of the future.

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2. Alfred D. Chandler, Jr. has masterfully chronicled the process in his two books *Strategy and Structure* (Cambridge: MIT Press, 1962) and *The Visible Hand* (Cambridge: Harvard University Press, 1977)—surely the best studies of the administrative history of any major institution. The process itself and its results were presented and analyzed in two of my books: *The Concept of the Corporation* (New York: John Day, 1946) and *The Practice of Management* (New York: Harper Brothers, 1954).

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Information Technology and Internal Firm Organization: Teaching Excerpt

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Introduction

As the Industrial Era gives way to the Information Age, there has been a shift in the internal organization of many large firms away from a "command and control" style structure toward a greater reliance on decentralized authority, teamwork, and supporting incentives. The new pattern has been compared in scale and scope to the organizational changes associated with the earlier industrial revolutions. Piore and Sabel [48] write of a "second industrial divide" between centralized mass production and knowledge-intensive "flexible specialization". Drucker [11] calls it the "third period of change: the shift from the command-and-control organization...to the information-based organization, the organization of knowledge specialists".

While this trend has been analyzed in a number of books and articles,[1] its underlying causes are not well-understood. One possibility is that the exhaustion of mass markets may have undermined the traditional organizational form to the extent it depended on sustained growth [48]. Other possible causes include the emergence of new competitive pressures which eliminate the slack needed in the old system [32] or the appearance of a growing supply of educated workers willing and able to take on the demands of information work [11]. Alternatively, the new system may represent a "workplace innovation", which had not been discovered or successfully applied in the past [28].

Just as the rise of large corporations coincided with a shift from handicraft to machine production and the development of technologies like the railroad and the telegraph [42], so the information-based organization might be related to the widespread diffusion of modern computing technology. Increasingly, computing technology can improve coordination and communications abilities throughout the firm. The development of the personal computer in the early 1980s shifted the location of computing power from large centralized "utilities" to workers' desktops. In 1987, there was a personal computer (PC) for every 30 employees in Fortune 1000 firms; by 1994, there was one PC for every

six.[2] At the same time, there has been tremendous growth in technologies such as local area networks, databases, and "groupware". These changes have transformed computers from their traditional role as "back-office" support for accounting, finance, and logistics to being fully integrated into all aspects of production. The development of decentralized computing technologies has also coincided with the emergence of business process redesign, which emphasizes radical changes in work organization supported by investments in information systems [20, 21].

In this paper, we examine possible relationships between information technology and internal organization by examining how information technology affects the location of knowledge within an organization, how IT interacts with limits to human information processing, and how new capabilities enabled by IT affect optimal incentives for knowledge workers. By examining these relationships we can understand what types of organizational practices are likely to support the changes enabled by IT, thereby linking information technology to organizational design. We then test whether the predicted set of practices actually appears in large firms using an exploratory dataset on organizational practices and information technology investments for 273 large firms.

Overall, we find that information technology is broadly related to a work system that emphasizes decentralized authority and supporting practices such as teamwork, subjective incentives and increased levels of skills and training in the workforce. This is consistent with the idea that valuable and difficult to communicate information resides with line workers and that the increased flow of information enabled by IT is best utilized by distributing information processing tasks throughout an organization.

Background

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[1] See, for example, [3, 28, 35, 44, 52].

[2] This number was computed from one of our datasets on computer expenditures. It refers to all Fortune 1000 firms with publicly reported employment information.

Information Technology and New Work Systems

There have been a number of recent studies examining the diffusion of work practices collectively termed "high performance work systems" [28] using case studies [12], industry studies [29, 38], and broad based cross-industry comparisons [27, 36]. The types of practices examined can be broadly grouped into three areas for the purpose of our discussion: *decision authority*, which includes teams and individual decision rights as well as related cultural practices (team building); *knowledge work and skills,* which includes skills, training and supporting practices (incentives for training and education, pre-employment screening); and *incentives*, which includes various aspects of performance-based pay increases and promotions.

Despite the number of analyses on changes in work systems, very few have considered the role that technology may play.[3] There are a number of reasons why information technology is potentially related to this organizational transition [10].

First, growth in information technology investment is of a large enough magnitude to be economically significant. Currently, over forty percent of new capital equipment investment in the U.S. is spent on information technology, resulting in a tenfold increase in its share of total capital stock since 1970. Meanwhile, the quality-adjusted price of computers has declined 6000-fold in the past thirty years [15].

Second, the recent advances in information technology are both novel and largely exogenous. Most of the fundamental technological breakthroughs that enable today's vast information infrastructure were made in the past three decades and were driven more by progress in physics and engineering than business demand.[4] The ever lower prices for IT

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[3] Kelley [34] is an exception, although her work on work systems and computerized machine tools represents only one aspect of IT.

[4] IBM originally estimated the total worldwide market for computers at just 10 units; with the advent of cheap, miniaturized components and microcomputers, over 10 million computers are currently sold annually [18].

are consistently delivered by the computer industry without any unusual effort on the part of computer users. Furthermore, the rapid accumulation of IT is primarily driven by these price declines, and thus is relatively exogenous to other events in the economy. Interestingly, the largest growth in the acquisition of computer equipment (from 1982-present) coincides with much of the literature on the emergence of new work systems, which suggests at least circumstantial evidence of a link.

Third, a number of authors have proposed a direct link between the diffusion of information technology and changes in the economics of organizations. Malone, Yates and Benjamin [40] argued that to the extent that IT reduced coordination and transaction costs, it would differentially favor market organization over hierarchical organization. Milgrom and Roberts [41] cite the exogenous price decline of IT as the primary driver in the shift from "mass production" to "modern manufacturing". Ichniowski and Kochan [28] argue that one possible reason that many of these new ways of organizing have not diffused rapidly, despite large economic benefits, is that they need to be coordinated with changes in information technology. Other arguments suggest links between various components of these new organizational forms, such as the rise of knowledge work and team-based organization [4, 6, 11] and the choice between centralized and decentralized authority within or between firms [14, 19, 37, 40]. However, few studies have been both theoretically driven and comprehensive in the sense that they examine sets of practices rather than arguing for specific individual dimensions.

What is the Relationship Between IT and Organizational Architecture? Elements of a Theory

As Jensen and Meckling [30] argue, organizational design involves the specification of decision rights, performance evaluation systems, and compensation systems, which Brickley, Smith and Zimmerman [9] collectively term *organizational architecture*. In this section, we consider how IT can alter the optimal organizational architecture of a firm.

To understand the effects of IT, it is useful to consider the different types of information used in organizations and the finite abilities of humans to process and communicate this information. Cheaper information can provide top management with more of the data needed to make decisions, issue instructions, and monitor the compliance of the work force. However, it can provide lower level workers with the information they need to make decisions without as much top management direction, provided workers have complementary skills and appropriate incentives to act on their private information. Furthermore, the growing flood of information can overwhelm the capacity of any given decision-maker, which may require a reallocation of decision-rights.

Decision Rights and the Specificity of Information

Hayek [25] distinguished "general" and "specific" knowledge, and this distinction was elaborated and applied to organizations by Jensen and Meckling [30] and further analyzed by Anand and Mendelson [1]. Specific knowledge is difficult to convey to others and is possessed by a limited number of individuals: " The more costly knowledge is to transfer, the more specific it is, and the less costly the knowledge is to transfer, the more general it is" [30]. Knowledge is specific in part because individuals know more than they can state [49], and also because information can be expensive to communicate and process. The critical insight of these analyses is that decision rights should be collocated with the necessary knowledge. As a result, organizations need to be structured so that actors with specific knowledge have the decision rights, and complementary general knowledge is made available to them.

Information technology can lower the cost of some types of knowledge transmission, enabling firms to take previously specific knowledge and reallocate it throughout the firm. As a result, the optimal allocation of decision rights will be determined by the relative importance of the knowledge that still cannot be transferred even with an information system.

To the extent that the "residual" specific knowledge resides at the top of the organizational hierarchy, information systems will generally enable more centralized decision-making. This argument was first made by Leavitt and Whistler [37] and reappeared in more recent work by Bolton and Dewatripont [8] and others. However, Aoki [2] has argued that the majority of valuable specific knowledge is increasingly held by workers,[5] suggesting a link between information systems and decentralized control. For example, the current trend toward increased customer focus, product customization and responsiveness, may increase the importance of time-critical, difficult-to-communicate information held by line workers.

Decision Rights and Information Overload

Whether information technology leads to increased centralization or decentralization of organizations is also determined by the tradeoffs between communications costs and bounded rationality.

In a world of costly communication and no limits on information processing by central decision makers, it is often optimal to centralize decision-making in order to economize on communications costs. Rather than provide all relevant information to all agents, information can be collected centrally, processed by a single decision maker, and returned to agents in the form of relatively low bandwidth commands. This allocation of decision rights is also favorable when coordination of agent activities is important and when central decision makers have a cost advantage in decision-making.

However this type of structure places heavy burdens on central decision makers. If there is a point at which the marginal cost of decision making increases with load, an increased

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[5] Aoki [2] writes that: "The tendency towards the delegation of decision-making to the lower levels of organizational hierarchies, where economically useful on-the- spot information is available, as well as the non-hierarchical communication among operating units, is becoming a more discernible phenomena on a world-wide scale, wherever conditions permit."

demand for decision making may necessitate a shift to decentralization to offload some of the burden on underused local information processors. Even if central decision-makers are advantaged in the decision-making process at any level of processing, at some point their induced efficiency will drop below that of the other agents [5], thus leading to increased decentralization. Furthermore, if the cost of coordinating multiple decision makers represents a barrier to decentralization, information technology can also make decentralization more likely by lowering these costs [39, 40].

In this argument, whether IT leads to increased centralization or decentralization depends on two factors. As described earlier, the first is the extent to which computers can decrease communication costs, potentially making decision-making knowledge less "specific".[6] However, this cost reduction in information transmission may result in increased information flow as well as a shift toward information intensive work structures [40]. Therefore, the ability of computers to relieve the burden of handling this increased flow of information or, in economic terms, their ability to substitute for or complement human judgment, becomes a key factor.

Computers are sometimes characterized as electronic brains that can replace mental effort in much the same way that other machines have been substituted for the physical work of humans. In this role, they relax the limits on human information processing capacity. For instance, complex planning algorithms allow airlines to schedule routes, departure times and seat pricing in ways which would have been impossible a decade ago.

[6] Bolton and Dewatripont [8] show that lower communication costs can enable greater specialization, which arguably could make knowledge more specific.

An alternative perspective is raised by Simon, who draws on a background in both computer science and economics. He has stressed the limitation of computers as substitutes for managerial attention, focusing instead on their role in generating information overload. IT may be effective in creating cheap data, but in most cases a human is still required to analyze the data and make decisions based on it. As he put it:

> The scarce resource is not information, it is the processing capacity to attend information. Attention is the chief bottleneck in organizational activity, and the bottleneck becomes narrower and narrower as we move to the tops of organizations. [51]

While IT has automated and vastly accelerated the chain of communication, human information processing abilities have changed little[7] and are still a strict complement for many types of data.

Incentive Systems and Observability

Jensen and Meckling emphasize that while decentralizing decision-making may enable the firm to take better advantage of local information, it can also exacerbate agency problems. Workers will not necessarily use their decision-making authority in the interests of the firm in the absence of an appropriate incentive system. Information technology has the capability to monitor work or aggregate information in ways useful for performance measurement, thus improving the quality of objective incentives. For example, Kaplan [33] describes a measurement system in one chemical plant that tracks 40,000 process variables every hour. However, unlike physical tasks, knowledge work is notoriously difficult to measure. Zuboff [53] describes how workers at one newly computerized factory would leave their computer terminals and move about the shop floor in order to appear to be "doing something" whenever the supervisor visited. Sitting and thinking, which may have been the best use of time in the computerized environment, was too easily confused with shirking. Similarly, applications like Lotus

Notes can enable increased information sharing among workers, but, without proper incentives, little sharing will actually take place [45]. Because sharing is difficult to quantify and objectively measure, a culture of teamwork and reciprocity seems to be the most effective way to encourage cooperation in knowledge work [13].

More generally, a variety of incentive instruments can foster effective use and dissemination of information, depending on the degree of observability. One can describe a *ladder of observability* with the following four categories:

1) If the decision actions and information on which they are based are directly observable and verifiable to an outside party (or can be deduced from other data), and the environment is not too complex, then an explicit contract can prespecify appropriate actions and rewards, for instance in the form of piece-rate performance incentives.[8]

2) If the decision actions can be assessed by the decision-maker's supervisor, but not prespecified and verified by an outside party, then implicit contracts such as subjective performance bonuses and promotions can be an effective instrument.

3) When the appropriateness of actions is not observable by outside parties or supervisors, but can be assessed by peers and teammates, Kandel and Lazear [31] argue that team-building exercises and cultural efforts to create a sense of group cohesion are needed. This will create a dynamic in which teammates punish shirkers and shirkers feel a sense of shame.

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[7] Simon (1976) has estimated that "we can handle only 50 [bits per second]", and that our short-term memory can store "seven plus or minus two items" [43]. Whatever, the true numbers, human processing capacity is bounded and not easily augmentable.

[8] For decision-making, unlike physical work, specifying the actions to take in each contingency and observing them will often be unrealistic. For one thing, determining what actions to take in each contingency is presumably the reason the decision-maker was hired in the first place. However, in some cases it may be possible to base compensation on final output, leaving the methods unspecified.

4) Finally, when even teammates cannot observe the appropriateness of an agent's actions, one option is to try to improve goal alignment, so that the agent internalizes the interests of the firm [2], perhaps by creating a sense of a shared vision through inspirational leadership.[9] In addition, it may be possible in this situation to get agents to reveal their private information by offering them a menu of contracts. Agents with different information will choose different incentive schemes, revealing their knowledge, but typically collecting information rent in the bargain. For example, by offering multiple plans to sales agents involving different combinations of fixed salary and sales-related bonuses, a firm can learn which territories have the highest potential by observing which agents choose high variable pay plans.

To the extent that IT renders observable activities that were formerly unobservable, firms will tend to use systems further up the ladder of observability. However, the opposite trend may be found if IT leads to decentralization of decision-making and greater reliance on team production because of the difficulties inherent in prespecifying and monitoring information work, information sharing and teamwork.

Complementarities

In addition to considering how these components of organizational architecture are related to information technology, we also consider how they relate to each other. In particular, in this section we will argue that the four components described earlier [decision rights (DR), knowledge work and inputs (KW), incentives (IN) and information technology (IT)] are complementary in the sense that the marginal benefit of adopting one set of practices increases with the adoption of the others [41]. While the complete mathematical model of this relationship is beyond the scope of this exploratory exercise, we will argue how each pair of characteristics is mutually supporting and identify

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[9] As Radner [50] has noted, this strategy has received little formal analysis by economists, but Peters and Waterman [47] emphasize its importance, writing: "[What is] the one truth that we were able to distill from the excellent companies research? ... 'Figure out your value system.' Decide what your company *stands for*. What does your enterprise do that gives everyone the most pride?"

relevant exogenous variables that drive a firm to choose one complementary system of these variables over another.

For clarity, the arguments for complementarity between each pair of the four design components (DR, KW, IN, IT) will be identified after each sentence of the argument with the symbol "+" representing "is complementary to". Pairwise complementarity between all design variables is a sufficient condition for arguing the complete complementarity of the system (see, e.g., Milgrom and Roberts [41] for a discussion of the mathematical issues of modeling complementarities).

Consider the case where information technology is broadly related to decentralized authority. This corresponds to the situation where valuable specific knowledge (not amenable to electronic transfer) resides at the periphery of the organization and/or information overload of central decision-makers is potentially a binding constraint (IT+DR). Since the key reason that authority is being decentralized is that workers have potentially valuable knowledge inputs, this suggests that this strategy is best supported by workers who are able to use their knowledge inputs effectively or have complementary human capital to decision processing (DR−KW). Furthermore, when workers provide valuable knowledge inputs and use private information, it also implies that effort will be difficult to measure. Thus, incentive structures must accommodate decreased observability by moving down the "ladder of observability" (DR+IN, KW+IN). As argued in the bounded rationality section, in this case information technology is likely to be a complement to knowledge work (IT+KW), and this work may be particularly difficult to measure and reward (IT+IN).

Summary and Case Evidence

To summarize the theoretical discussion, if IT is associated with an increased importance of local knowledge, with easier transmission of coordination information, or with more severe information overload at the tops of hierarchies, we can then infer the adoption of a

work system incorporating the following components: decentralized decision authority, increased reliance on knowledge work and knowledge workers, incentives adjusted for decreased work observability and greater use of information technology.

There are a number of case observations consistent with this evidence. For example, in Phillips 66 [24], pricing decisions had traditionally been made by a centralized staff of experts who monitored market trends, analyzed purchasing data and made pricing decisions for local markets. Recognizing that these central experts lacked timely and accurate knowledge of local market conditions, an information system was built that provided local managers with broader market trends enabling them to adapt pricing decisions more effectively to local market conditions. This decentralization of decision rights was coupled by centralized performance monitoring, which was used for "coaching" the local decision makers and making subjective judgments about their performance. At the same time, systems were installed for central managers to make them able to screen and assimilate information on market conditions better, enhancing their ability to make high level strategic decisions and monitoring the actions of line managers without experiencing information overload. The combination of these organizational changes and information systems innovations was regarded as instrumental in returning the company to profitability in the late-1980s, and can be linked directly to at least $30 million in revenue increase or cost savings.

Other firms have implemented these types of "empowering" information technologies without making the complementary investments in organizational change. For example, when automated process controls were introduced at the Tiger Creek Mill [23, 53] which allowed workers direct feedback and control over production cost, benefits from the technology stopped being realized after a short "honeymoon" period. One contributor to this problem was that the previous "command and control" style hierarchy in the mill was not changed to provide workers either the explicit rights or incentives to improve the process, even though they were best positioned to make process improvements.

The same interactions between technology and organization experienced in manufacturing environments also appear in services. Orlikowski [45] describes the experience of a consulting firm (Alpha Corp.)[10] which made an executive-level decision to install Lotus Notes on all the computers in the firm. Management at Alpha believed that the need to share specialized knowledge across the firm could be addressed simply by making collaboration technologically feasible. Initially, however, most employees took little advantage of the newly introduced information sharing capabilities. One possible explanation for this outcome is that the incentive systems at Alpha stressed individual effort and expertise, rather than group or organizational level performance. Because time spent on making one's private information widely available through Lotus Notes came at the expense of "billable hours", there was little incentive to invest in it.

Another organization provides an interesting contrast: Info Corp. implemented the system in the telephone customer support area, a group with a long history of collaborative work and a team-based subjective incentive systems [13]. The system was fully accepted almost immediately, leading to substantial improvements in service levels without staffing increases. Over time, Info Corp. expanded the range of capabilities of the system by linking the telephone support group to other departments in the firm and altering the structure of work groups to utilize workers' specialized skills better.

Several economic insights are suggested by these cases. First, not all managers know how to combine technology and organization appropriately. Some firms are experimenting with new technologies and not all of these experiments are successful, particularly when technologies are implemented with little change in other aspects of the organization. Second, organizations often gain considerable benefits by decentralizing decision authority when combined with the necessary information and appropriate management controls. However, either providing the incentives to the wrong parties (e.g. Tiger Creek) or relying too heavily on individually-oriented objective incentives (e.g.

[10] Company names in these case studies are disguised.

Alpha Corp.) may discourage information sharing and effective use of information to improve production, even when it is technologically possible and desirable.

Empirical Results

Omitted.

Summary and Discussion

In this paper, we present an outline of a theory that suggests how organizational architecture must be matched to the use of information technology. Given that humans are limited as information processors, that highly specific information is likely to reside at lower levels of an organization, that knowledge is likely to be complementary to technology use, and knowledge work is likely to have a substantial intangible component, we hypothesized that information technology would be associated with a decentralized organizational architecture.

Using new data collected specifically for this analysis, we find that IT is broadly associated with a work system that includes decentralized authority, incentives that account for decreased observability, and increased importance of knowledge workers and knowledge work. This relationship appears to be consistent across different industries and robust to variations of our measures. In addition, after controlling for workforce composition in our analysis, we find that this relationship is not simply due to the types of workers (skilled, professional) employed at these establishments.

Limitations notwithstanding, we provide some of the first large sample evidence of a link between information technology and new ways of organizing work such as the "knowledge-baed organization". We have also been able to harness some of the recently developed tools in organizational economics to explain productivity differences in the use of a key enabling technology. The quality-adjusted investment in IT by firms is likely to continue to increase by 20% annually for at least a decade, suggesting that the issues addressed in this paper will become increasingly important in the future.

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THE EXPENSE TRACKING SYSTEM AT TIGER CREEK

Adelman's Dilemma

In September 1983, Carl Adelman, manager of the Tiger Creek mill, reread the memorandum from a vice president of American Products Corporation (APC). In two weeks top managers from APC's Industrial Products Company were coming to see and hear about the Expense Tracking System (ETS). In March 1982, the ETS was installed on two of the mill's papermaking machines to provide operators with information about production expenses; the resulting cost savings surpassed everyone's expectations. The ETS was one of the few applications of advanced information technology that represented innovation in the service of economic criteria as well as another corporate value--involving workers in the basic operations of the business. The ETS "success story" spread throughout the corporation, and plans were being made to reapply the ETS in other mills.

Although VIP tours of the mill were commonplace, Adelman knew he needed special preparation for this one. He was concerned about the last point in the memorandum: "...be prepared to present future plans and anticipated costs savings for the ETS." Cost savings had been dramatic during the first year, but they had reached a plateau, and he did not know why. Adelman wondered if the mill had reached the limit of savings from the ETS, or was there something else interfering with the proper utilization of the system? He was determined to find the answer by talking to the people involved with the ETS.

APC's Industrial Products Company and the Tiger Creek Mill

Divisions in APC's Industrial Products Company were evaluated not only on quality, service and cost production, but also on the long-term health of human and physical assets (e.g., safety). The Oak Woods Division, one of three divisions in APC's Industrial Products Company, manufactured specialty paper products. Evaluations of the Oak Woods Division have varied over the last twenty-five years. In the 1960s it was "riding high" as the sole producer of some of APC's best specialty paper products. However, as more manufacturing sites were purchased or built,

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This case was prepared by Research Associate Gloria Bronsema and Assistant Professor Shoshana Zuboff as a basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

Oak Woods fell behind. With older technology and an adversarial labor-management climate, its costs were higher than competitors and there was no effort to change. During that period APC executives described the division as an "albatross," but by the late 1970s Oak Woods was again viewed with high regard--it had lowered its costs and created a more collaborative work environment.

The Tiger Creek mill was part of the Oak Woods Division, and manufactured four brands of specialty paper products. It competed with other mills in the manufacture of three of these. Competition was especially fierce between Tiger Creek and the Cherry Canyon mill. Cherry Canyon was one of APC's newer and highly productive mills. It had an innovative work organization based on a team structure and guided by principles that emphasized the value of a flexible and highly committed work force. The Industrial Products Company assigned production to each manufacturing site on the basis of capacity and costs. If Cherry Canyon was not at 100% capacity, it received the allocation because it produced at a lower cost. According to an APC executive, "Cherry Canyon can put finished product on the Tiger Creek loading dock cheaper than Tiger Creek can!" Tiger Creek was striving to close the gap.

The Tiger Creek mill was organized into functional groups responsible for different components of the production process--boiler and water treatment, pulping, papermaking, finishing and warehousing. The mill employed 1600 people, with a manager to hourly worker ratio of 1:5. The management hierarchy had four levels: mill manager, superintendent, general foreman, machine and crew foreman. (See Attachment A for an organization chart.) The top three levels of management worked day shift; the crew foremen worked shifts along with their crews. Managers typically had engineering backgrounds. The average age of managers in the mill was 35 years old with average seniority of ten years.

Turnover of management was 5% to 6% per year, slightly higher than the corporate average. Adelman attributed this to the "stresses of a changing organization." Recruiting efforts were aimed at attracting individuals with the capacity to facilitate organization change in addition to their engineering skill. Three factors were used in the evaluation of managers in the mill: performance, length of service and responsibility level. Particular attention was paid to cost and production results. Managers were further evaluated on "skills," e.g., problem solving, initiative, communication, ability to handle conflict and technical competence. Performance appraisals occurred every six months, and managers were ranked on a bell-shaped curve.

Hourly workers, "operators," employed at the Tiger Creek mill belonged to the Industrial Products Workers Union (IPWU). Until four years ago the labor-management relationship was antagonistic, but "cautious cooperation" had evolved over the last four years, thanks to the effort led by Adelman and his boss, Norman Joiner. Division and mill management were being evaluated on their ability to implement change, particularly in work systems.

Joiner and Adelman believed that operators needed to take more responsibility for problem solving and decision making if the mill was to be competitive in the 1980s. Their strategy was to turn the union/management relationship into a "partnership;" their tactic was communication. This was the first step on the road to the implementation of a work organization based on employee commitment instead of hierarchical control. The competition with Cherry Canyon had convinced Tiger Creek's top managers that creating a more flexible organization attuned to cost reductions was critical.

Many of APC's senior managers had confirmed from considerable experience in new mills that allowing workers at the point of production to assume increased responsibility provides a significant source of competitive advantage. They encouraged skill development, emphasized each person's ability to "contribute to the business," and favored more flexible and less hierarchical work organizations. Senior executives were keenly interested in the Tiger Creek effort. They could no longer afford to think of flexibility, cost consciousness, productivity and cooperation as characteristics of nonunion mills only.

For the past four years Joiner and mill managers had been meeting with union leadership to discuss the competitive situation, share confidential business information (e.g., unit costs), and begin a joint goal-setting process to develop a common vision of the future. Joiner said,

> My philosophy was to share all information with the union. We spent 2-3 days a month in meetings. If you share information with people they will come to the same conclusions you do.

Continued dialogue led to a new labor-management climate; both sides agreed that "change" was a legitimate goal.

The union accepted the necessity for cost reductions, but it exhibited little willingness to make changes or take risks. While the union perceived its mission to include the protection of the seniority system, some operators were beginning to question this. One experienced paper machine operator who had been involved in union activities summarized what some believed to be a key problem:

> I'm pro-union, but I have to admit it's not the best thing for making changes. The union can protect the weakling at the expense of really competent people who should be able to move up but they can't because of the seniority system.

Although union officials did not agree to flexible operator roles, they did allow operators to go on "special projects"--a management innovation in which operators were invited to work on projects with managers and engineers. During special projects operators were relieved from their typical responsibilities and the positions of other operators in the department were elevated a notch and given a corresponding pay increase (approximately 12%) to assume the duties of their absent co-worker. For

example, if the highest level of operator (level 3) went on special project assignment, levels 2 and 1 operators were "promoted," and a person was hired from outside the department to fill the level 1 position. When the special project ended, the operators returned to their previous positions and pay grades, and the "new hire" could bid on other job openings.

Automation at the Tiger Creek Mill

Tiger Creek followed the familiar path to computerization with large batch processing of payroll and financial data. By the mid-1970s key operating factors of the production system were on the computer and these were summarized in management reports once a day or week. By the early 1980s punch cards were being replaced by terminals, and people all over the organization were directly entering data.

The mill was also converting its process control technology. Process controls had been pneumatic (an earlier analog technology that used variations in air pressure to transmit signals), and process operations were decentralized and controlled from panels located near each machine. In this decentralized mode, decision making depended upon an operator's know-how developed during years of experience.

In 1978 Tiger Creek began converting from pneumatic to digital controls. Digital controls were sensor based and used binary code to transmit data from and instructions to process controls. The control data could be linked to a computer, thus creating the opportunity for information systems that integrated real time data from the production process for the purposes of monitoring and analysis. Process operations in the mill were 30% converted to digital by 1983.

In 1979 the first interactive application of computer technology was installed in the mill. With digital controls, data was lifted directly from sensing devices in the manufacturing process and displayed on terminal screens for operators and managers. As a result operators spent more time in centralized control rooms that housed computer systems. Operators and managers used the technology to monitor and change process variables when they deviated from "centerline;" i.e., when variables exceeded the acceptable limits for optimum processing. Many of the centerlines were programmed into the control system to form a "closed loop" system (i.e., systems that did not require human intervention).

Changes in process control technology provided an opportunity to install systems to collect more detailed, comprehensive, and timely information concerning process variables. These systems provided data on production rates, machine operating conditions and product quality, and were considered "open-loop" or "passive" because they did not have the capability to execute decisions without the involvement of the human user.

While there was an increasing amount of process, production and quality data immediately available, feedback on costs was limited and delayed. For example, cost data in the papermaking department were obtained on a monthly basis. The calculations needed to determine cost impacts were time consuming and complicated, and, because they required

management analysis, were only of value in long-range planning. Operating decisions were based on available information which was limited to production rates, machine operating conditions and product quality information. Operators were unaware of many of the cost implications of their decisions and had no way of confirming the most cost-effective alternatives.

While average costs per run on paper machines tended to be consistent, closer analysis of individual runs showed significant cost swings (called "wobble") of up to thirty dollars per ton. A reduction in the production cost wobble on the paper machines could offer substantial savings on the 90 tons produced by one paper machine each day.

The Selling of the ETS

New technology offered a potential solution to the need for better utilization of cost information. In 1978, while process controls were being installed on one of the paper machines, Bob Phillips (staff department manager) and Harvey DeWitt (division staff engineer) "slipped through" an add-on system to monitor energy expenses. Though this system was limited, actions on its feedback resulted in cost savings. Phillips and DeWitt hoped that these savings would serve as convincing evidence in their proposal for a more comprehensive ETS.

In late 1979 they proposed a project to obtain timely expense data to achieve savings on two paper machines. They requested the purchase and installation of one general-purpose computer with associated communications equipment, three terminals and three printers. The software provided instantaneous fiber, chemical and energy usage information for operational cost optimization. These three categories constituted 80% of the total expense for a ton of paper.

The rationale for the ETS was set forth in a report written by DeWitt and two other process engineers:

> The primary objective of the ETS is to place timely and accurate expense information in the hands of the people making minute-to-minute process decisions, the operators. By increasing the visibility of these ongoing production expenses, better decisions will be made, reducing the cost for a ton of paper.

In early 1980 DeWitt requested an appropriation of $700,000. The annual savings from the project were estimated at $200,000. The appropriations process began with approval from the papermaking superintendent, and continued up four more levels of the hierarchy: mill manager, division manager, manufacturing director and vice president of industrial products. The process ended with approval from the Corporate Budget Review Board, a group of senior executives that included the president and chairman of the board.

The appropriation was to receive "astronomical scrutiny." Although ETS was an opportunity to involve operators in the basic operations of the business, some managers were ambivalent. John Loveman, the superintendent in the papermaking department explained:

> It means a subtle power shift. Taking the decision making out of some people's hands and giving it to others. There were difficulties in getting the appropriation because it was new and different in three important ways. The technology was going to make accurate information available. The system would give full license to operators to manage the business on a cost basis. They would have cost data that managers never had. And finally, it would be a system that did not help the machine. Instead it would be strictly for using information from the machines to make better decisions.

After a one-hour meeting with Phillips and DeWitt, Tiger Creek's mill manager, Adelman, was "110% supportive" of the ETS, but it took months of dialogue with divisional and corporate managers before management "buy in" was secured. Phillips explained a major barrier:

> It's the age of senior management in the division and corporate. Most hadn't been exposed to computers, and others had a negative experience. So they wanted reams of data beyond the normal appropriations process. They were afraid of the unknown. They kept saying, "It (ETS) doesn't feel good. . . Are you sure?"

Phillips and DeWitt continued to explain the ETS benefits--"more and better analysis, historical analysis trends, comparative analysis, minute-by-minute data . . . the big picture." Phillips explained the "selling point" of the ETS:

> Papermaking is so complex; it exceeds the operator's ability to assimilate and integrate information. Operators experience data overflow. They need quality information. Because operators couldn't assimilate all the data, and because with the ETS we could give quality information to operators--that was our selling point for the ETS.

A concern at the mill level was union reaction to the proposed ETS project. Historically, responsibility for costs was a management function; many managers believed it was "risky" to give cost data to union workers and wondered if they would accept the responsibility. When the ETS was explained to union representatives, they felt obligated to live up to their agreement that "change" was a legitimate goal. While the union did not actively support the ETS, it did not say no. Union leadership maintained a passive posture throughout the life of the project.

The ETS was installed on two of the seven paper machines. Those involved in the operation of the two machines included nine managers (the superintendent, the general foreman, 2 machine foremen, the process engineer and 4 crew foreman), and 24 operators (8 operating crews on the

two paper machines). There were three levels of operators on each crew--machine tender, back tender and third hand. (See Attachment B for job descriptions.) The paper machines ran seven days a week, and the 24-hour work day was divided into three shifts. One crew foreman supervised two crews (one per machine) on each shift. Crew foremen and operator crews rotated; i.e., on a given day 3 crew foremen and 6 crews were on, and 1 crew foreman and 2 crews were off.

Phillips and DeWitt believed that operator ownership of the project would be crucial. To secure their involvement early on, as well as to dramatize the uniqueness of the project, Phillips invited two operators, Guy Needham and Larry Deutsch, to participate in a special project. Phillips had worked with them on another special project, and they had done an "outstanding job." Phillips wanted the ETS to be perceived as an operators' tool, and in that vein used a tactic that broke tradition. Needham and Deutsch, not managers or engineers, accompanied Phillips to corporate headquarters to "sell" the ETS project to senior management.

Funding for the ETS project was approved in late 1980. It had taken almost two years to move from the conception to the funding of the ETS.

<u>ETS Implementation and Cost Reductions</u>

By virtue of their special project assignment, Deutsch and Needham were the first operators in the papermaking department to formulate and work with the ETS. According to Phillips who had formal responsibility for developing the system, he not only wanted these two operators to contribute their knowledge, but to accept accountability for its success. Phillips explained,

> I wouldn't allow any line managers on the ETS team. ETS was an operator tool and they're the ones who need to be involved. I gave accountability to Deutsch and Needham. It was their project, and they made the decisions.

During 1981 Deutsch and Needham received special training in "how to run meetings," and were the liaisons between paper machine operators and process/software engineers working on the ETS. One engineer described the operators' contribution:

> The operators helped define cost variables, build the data base and design the screens. They contributed things no one else even conceived of. They decided what information they needed and how to display it.

By March of 1982, software had been written, hardware was installed, and the system "behaved" from an engineering standpoint. Three additional months were devoted to training operators and managers to operate the ETS. (See Attachment C for ETS chronology of events.)

With the ETS, operators had increasing responsibility for costs, process stability and troubleshooting because they had immediate data and the closest proximity to the process. The high quality of data meant that operators could make judgment calls that were once the exclusive domain of managers and engineers. Many operators no longer resorted to their idiosyncratic determinations of centerlines, as they now had objective data on which to base their choices. The "baton pass" of information between shifts became automatic, since the same data base was accessible to each shift. The ETS also created a powerful correlational capability. Operators could relate their decisions to the quality of paper coming off the machine, and were able to determine the precise factors that had contributed to improved quality, or to correct negative trends more quickly.

The ETS was implemented under budget, and in March of 1983 the initial results were published. While predicted savings had been $200,000 during the first year, actual savings were $240,000. This calculation was based solely upon "quantifiable savings directly linked to the use of the ETS." The actual savings rate improved the project's rate of return and shortened the payback period. The cost wobble had been reduced. Operators on the project returned to their previous jobs; Phillips took a new position and was replaced by Ernie Gomez as staff department manager. The ETS was declared a "success."

The Cost Savings Plateau

Gomez wrote a report that documented the four areas of activity that had the largest impact on savings. First, greater awareness of operating expenses motivated operators to change their behavior. For years operators had been told to increase their usage of "broke;" i.e., to walk to another area in the department to retrieve broken rolls of paper or scrap fiber and feed them back into the process. "We always knew it was smart to use broke," one operator said, "but we hardly did it until we realized how much savings was involved." The ETS data led operators to increase their use of broke, accounting for almost half of the first year cost savings.

Operators also found cheaper methods to accomplish every day tasks "as a result of increased cost awareness." They discovered a method to substitute low-cost fiber while still maintaining the quality of the final product.

Another area of major cost impact involved the optimization of centerlines on key operating variables. The ETS allowed operators to challenge some centerlines and demonstrate how changes would result in lower costs. For example, operators discovered a different steam balance among the drying rolls that reduced total steam consumption. This change

in the pressure centerline resulted in substantial savings. Gomez said:

> Normally centerline changes, especially "sacred" centerlines, are strongly resisted by management. In this case, operators were able to easily demonstrate that costs were reduced significantly with the optimization of this process variable. The crew that initiated the testing had long believed such a change would result in substantial savings, but previously had no confirming data to convince others.

The third area of savings came from better process definition of new equipment. Data from the ETS was used to expedite the justification of new equipment as well as to specifically define under what conditions it could function at reduced cost. In one case operators discovered that steam coils, which had been purchased at considerable expense to save money on energy costs, were actually increasing expenses.

Finally, Gomez discussed the operators' enhanced ability to solve problems using the ETS data. Operators were able to use abrupt swings in cost data to identify instrumentation out of calibration that could have resulted in more severe problems. Cost data were also used to schedule downtime and other aspects of machine operations and on many occasions these decisions generated impressive savings.

Cost savings from the ETS had surpassed everyone's expectations, however, the most significant gains were made during the first eight months and reached a plateau after one year--"not a flat curve, but only small inroads now." There was a decrease in the number of dramatic new insights, and the system was being used for more routine monitoring. There were varied opinions about the plateau. Phillips believed that since managers remained formally accountable for costs, it had been difficult for operators to sustain a feeling of ownership of cost-related problems or for managers to encourage them in that ownership. Loveman seemed to accept the plateau as a natural development and talked about using the system to enhance paper machine stability and equipment reliability:

> The glory is gone. Now it's more a question of monitoring costs than of big discoveries. We are looking at a smaller band width but still finding important adjustments that can be made.

But DeWitt strongly disagreed. He believed that only 30% of the system's potential had been exploited:

> In order to get the other 70% we would need a positive and active program in management or the union. They would have to really support the operators using the ETS.

Adelman wondered--had a real ceiling been reached on the degree of possible cost savings? Or were there other explanations for the dwindling insights from the ETS? He learned that only two months before

Gomez's report, David Oswegan, a young process engineer, issued an Expense Tracking Problem List. (See Attachment D.) Oswegan outlined four sets of concerns--"barriers that are keeping the department from utilizing the ETS to its fullest potential." These included: (1) data problems, (2) outages in user skills, (3) user/computer interface problems, and (4) implementation problems.

A lack of in-depth operator understanding of the new system was evident in each of the problem categories. However, the problem list did not identify precisely what kinds of skills were needed or what it would take to develop them. The relative superficiality of operator understanding seemed to haunt the ETS project. Adelman decided to see how much of the difficulty could be traced back to the training process.

Training for the ETS

Deutsch and Needham were responsible for operator education. Needham wrote an ETS operator user manual, and both operators trained their peers. (Managers were trained one-on-one by an engineer.) Two levels of training were planned; level l was directed at reducing "computer phobia" and teaching concrete skills, e.g., terminal operations. Needham described the training:

> I trained them in groups on the terminal. We went through each page of the system, and I had them go through frames to build graphs of costs.

The second level of operator training was to focus on the interrelationships among process variables and costs. Deutsch explained:

> It is important to understand the interrelationships between different parts of the process. If you do something to one part of the equipment you can see the cost effects in another part of the equipment. You may think you are doing a great job saving money if you're just looking at one piece of the process and not realizing that it is costing you more money on another piece. So you really have to understand these relationships, these interdependencies. You have to work with them experimentally to see what affects what, under what conditions and how. This computer won't lie. You look at it and you instantly know if you've done the right thing. People have to be taught to understand the dynamics between different parts of the process.

Deutsch explained the approach he intended to use in the second level of operator training:

> The experimental approach to training was my own idea of how to train people. We're always running experiments on the machines, and my intent was to show what a resource this system (ETS) was. I would have them make changes in the paper machines and then come and see what it did to the ETS.

A necessary condition of Deutsch's approach was a risk-free learning environment.

> I wanted them to understand the ETS so I told them, "What you do with it won't affect the operation of the paper machine . . . so it's okay to screw up, you won't shut anything down."

Deutsch found he "loved" training people, and he knew he was good at it.

> I knew how to teach them because I knew the kinds of things they cared about. I knew what kinds of problems they had. I knew what kinds of things they would want to know to help them solve those problems. I knew how it would make sense to them.

Needham and Deutsch also discovered their "students" learned in different ways and at different rates. One process engineer close to the project estimated 30% of the operators had been relatively indifferent. He believed that some of these were capable of learning, but were simply not interested. But for the others, mastering the skills required to utilize the system would be difficult. He estimated that another 50% learned more slowly, but were capable of becoming proficient if properly trained and motivated. The remaining 20% developed an in-depth proficiency very rapidly. The operators who were most effective were those willing to experiment. One said,

> Only 10% of us (operators) really know what to do to reduce costs. We have guts, we aren't afraid to try something. We take risks and change steam pressure to see if we can cut down total steam used.

According to Phillips:

> The operators who understand the system use it all the time. When the ETS was down for 45 minutes they believed they couldn't go on without it.

An operator who was proficient in using the ETS described his feelings to Adelman:

> Before computers we didn't have to think as much, just react. You were involved with the process, you knew what to do and you just reacted. But now you see the effects (the costs) of your reactions and it gives you something to think about. You feel more in control now.

Many operators realized they needed new skills to feel "in control." Before technologies like the ETS, papermaking was more intuitive--". . .an instinctive thing like driving a car." Now papermaking was becoming more "scientific." One operator explained:

> Now you just don't walk out on the floor and tweak a valve; decisions to do things are based on facts. You need to

> experiment with things, look at the data, figure out trends--and <u>then</u> you can decide what to do and tell the computer.

Another operator described his "scientific" approach: "Now I analyze data to prove or disprove theories."

Level 1 training was accomplished, but in spite of Deutsch's enthusiasm level 2 training was abandoned when his special project assignment ended. His explanation:

> The managers came in and started taking over. . . They would come in and change the ETS and not tell us what they had done, so we couldn't use it . . . They discouraged us from exploring more aspects of the data to try new things. The managers were all over us, formalizing things right away, giving us rules, telling us how we had to use it, second guessing us, wanting to get their names on every report.

As a result of the limited training, operators were left to their own devices when it came to figuring out how to use the system more creatively. The qualifications procedures tested only superficial skills. As Phillips described it:

> Qualification testing wasn't truly skills based; it didn't deal with how to use the information, only how to get information out of the system. Its focus was on key strokes and reading displays on the screen. We didn't ever take skills training to the point of telling them how to use the system to impact the business.

Adelman discovered that the operators who had the least training on the ETS did not utilize the system as much as other operators. Several spoke of their fear of making a mistake, being embarrassed, not understanding what it was all about. Yet despite training problems, some operators made a significant effort to learn about the system and to use it in an imaginative and productive way. Usually one operator on each crew was the primary user of the ETS, and the organizational level of the primary user varied. Because the ETS meant that the same data was theoretically available to any crew member, occasionally some resentment was felt. A machine tender said:

> A younger person having more data than the senior person was unheard of! We (machine tenders) had to spend twenty years to get that data from our experience.

<u>Sources of Operator Motivation</u>

Adelman wondered what had motivated these workers to make such a contribution to the business. He found that many operators believed that they had long known how to improve the operation but no one in management would listen to them. The ETS had provided them with a means to translate their hands-on knowledge into "hard data."

The ETS is a vehicle for us to talk to our managers. Managers only believe quantitative data. If our managers read the printout and it says that snow is black, they will believe it. All along we have known the best way to run this process, but we couldn't prove it to them. Now we have a common ground for talking to them.

Operators discussed their experiences with the ETS and described their motivations to Adelman:

When I started my career I chose not to be a manager. I chose to be a blue collar worker. I chose not to go to college. I did not come here to make decisions for the company. I did not come here to run the business. Money is not really an issue. The incentive for me with the ETS was that I knew it was going to be made part of my job. I didn't want to fumble. I like to know what the hell I am doing. . . I want to be competent at my job.

* * *

If I am going to do something I want it to matter. I don't want to ride in a plane, I want to fly it. I don't want to do things that don't matter a shit. I don't want to just take orders, I want to do things.

* * *

Maybe the day will come when I am faced with a computer replacing me. I should learn as much as I can to make myself valuable. When the old world falls apart I'll be one of the ones who can be salvaged.

* * *

We have a bigger stake in making this place run than managers have. They are college boys and can get jobs other places. We are not going anywhere.

* * *

We feel the managers are the hired help around here, and we are the permanent people. This is our mill. We have been here for anywhere from 10 to 35 years, and watch the managers come and go. We know that the company will send production to wherever it is cheapest. If we can't be competitive, we are going to lose jobs.

The View from the Control Room

To his surprise, Adelman found that operators who used the ETS proficiently believed that their ability to contribute had been curtailed by their managers. When asked what accounted for the plateau in cost

savings, the operators were in unanimous agreement. At first managers had felt "threatened" and had "resisted" the operators' full utilization of the ETS. But by the end of 1982, seven months after the ETS was installed, operators believed that managers had tried to "steal the thunder" from their ETS discoveries. Faced with this, operators began to withdraw their care and concern. One operator said:

> Everything was great until management took it over. It was our system and they got their paws on it. We said fine. You want it? It's yours. You do it. That is when we washed our hands of it.

Another operator expressed his frustration to Adelman:

> We were committed to this project blood and guts. But managers just want their glory. Why should we support them? They've really discouraged us from participating or experimenting.

Other operators complained that management had used the ETS data to identify centerlines and then require the operators to hold to those parameters. Many operators believed the abrupt turn to a rigid centerline program was evidence of managerial resentment of the ETS. They questioned how managers could be committed to the principle of the ETS as an operator tool if they were going to use the data to immediately impose centerlines. As a result they found that:

> It was no longer possible to play around with the thing, to experiment. But that is how you have to use the system if you are going to get at its potential.

Some operators designed their experiments to be conducted on the graveyard shift--10:00 p.m. to 6:00 a.m. This way they were free to "play and learn" without management pressure. They could later present the results of their experiments to managers on the day shift, and would be well equipped with the documentation to back up their arguments.

Operators perceived managers trying to make the system their "plaything," to take credit for the savings achievements, and to use it to track individual performance.

> Managers want to give us responsibility but as soon as we hit on something that is really good they jerk it back and start writing reports about how well <u>they</u> have done.

* * *

> The ETS has become a vehicle for management to check up on us. They can pick up what changes on a minute-by-minute basis. A report was issued a couple of months ago. It emphasized being able to track what the operators do. We decided to call the system the electronic tattletale. As long as things are going well, they don't care about tracking

> performance. But if it isn't running well they start digging around in the data looking for someone to blame.

Finally, before the ETS savings report was officially released in March 1983, operators noticed what they believed was a sudden escalation in the degree of bureaucracy that surrounded the ETS. They received sheaves of memos from their crew and general foremen. Though many of the memos had nothing to do with the ETS, they characterized the tone in which they were written--"petty . . . arrogant . . . hot air . . . three pages to say nothing." Another event outside the unit had contributed to the perceptions of stifling bureaucracy. Several operators on special project assignment (not on the ETS project) had abused the position. Management had identified them as "late for work . . . not working very hard . . . goofing off." As a result, managers in the papermaking department wrote a memorandum stating new rules for special projects. These outlined when and where to report to work, areas of the mill that were off limits, when to take lunch breaks, whom to report to, whom to notify when they leave their work area, etc. The memorandum was signed "Crew Foremen Group." The paper machine operators were furious, as they believed the managers were afraid to sign their names to the memo.

Operators believed that managers in the department had never really bought the concept of the ETS, but had "jumped on the bandwagon" when the project appeared successful and began to win a great deal of senior management attention.

> Managers were not really involved in the decision to develop and fund the ETS. It kind of sailed in the window like a paper airplane. But when it looked like a winner, they were all here picking and grinning. When anything goes wrong they look for scapegoats, and when something works, they take credit for it.

Indeed the ETS had received special attention. Division management had written notes on the ETS savings reports--"Some excellent problem solving through teamwork! Congratulations! It's great to see these hard won dollars roll in!" The operators pointed to the report where the individuals responsible for the savings were listed. All but one of the names were those of managers. An operator explained this behavior:

> All that managers care about is exposure. They want to do things so that other people up in the hierarchy will see what they are doing, will know that they are doing "good work." For managers, exposure is their bread and butter. Once they found out that the ETS was going to be really looked at by corporate management, they started to latch on and wouldn't let it go. They are looking for the glory from the system. They elbowed the operators out of the way and stole their thunder.

Operators believed that some managers were mortally afraid of being seen as expendable.

> Think about it. We have rooms full of managers during the day. They think that they are necessary to running the mill. At 5:00 most of them go home. But the papermakers run the mill all night long and production is always better on the weekends when there are few managers here. They do not really have the power they would like to have because they do not have the experience we have.

* * *

> The managers have a bigger job security problem than the operators. We have a union, they don't. This company is changing its philosophy. It's a big fear, so they have to ask themselves, what am I contributing? And they have to be able to show something, so they take over what we do on the ETS.

In their view, managers were paralyzed by the precariousness of their jobs, and the threat of being discovered as expendable.

Many of the operators saw an explicit connection between the information systems that were available to them, and the growing confusion as to the purpose and function of the middle manager. One operator summarized the problem:

> With this new technology it's easier for operators to take on a managerial role because we have more data. There is data every few seconds on everything that's going on. Plus, managers don't have to be standing guard over you to find out what is happening. They can come back in ten days and with the computer they can see everything that happened. This eliminates the middle man. It is like going right to the farm to buy your eggs.

The View from the Office

As Adelman continued his data gathering among managers involved with the ETS, he found the same events interpreted differently. Managers were well aware that "cost responsibility still resided high in the management organization." They continued to be formally accountable for and evaluated on costs. This accountability made them sensitive to division and corporate management's interest in the ETS. It had become a symbol of Tiger Creek's ability to adapt to its new competitive pressures. Loveman said:

> The ETS was the first savings project for passive information utilized by operators. Division management was out on a limb, and they had high expectations. Their message to us was--"it will not fail!" The ETS became a symbol of success or failure in looking at our mill, at our ability to adapt. We made a presentation to division senior management and they said--"Make it successful or else."

Since the funding appropriation, division management sent frequent notes asking, "How's the ETS coming?" There had been several visits by managers from other divisions to learn about the ETS.

Some managers conceded that the new emphasis on centerlines contradicted the goals of flexibility and decreased opportunities for operators to influence the business. One manager close to the operation described the centerline program as a "knee-jerk reaction of crew and general foremen to get the operators to behave the way they want them to behave." But other managers maintained that their concerns were legitimate. They sincerely doubted the operators' ability to handle more responsibility and feared giving cost information to a union work force; it implied a level of cooperation and trust that they associated with nonunion organizations. Furthermore, giving the operators free rein to influence cost decisions might mean that the mill would lose money--losses for which managers would ultimately be held accountable. Loveman summarized:

> Managers are fearful of taking the risk to let operators have a greater impact. All managerial decisions should be based on data and facts. Everything must be justified by tangible facts and/or money. . . I will admit that under these conditions it is hard to get the leeway for experimentation to generate data that might persuade us to do things differently.

The interest in establishing more rigid centerlines was also fueled by the general foreman's observations of the behavior and attitude of some operators who did not want to use the ETS. The older operators were seen as "resisting data-based reasoning."

> The old-timers are machine tenders with a macho image; they know best and shouldn't be questioned. They don't want to use it (the ETS) to prove things because that would give more importance to the data base than to their experience. They're older and feel they know how to run the business better.

Loveman claimed that the amount of discretion given to operators to use the ETS depended on the results they had achieved. Those who had demonstrated success were given more discretion than those whose results were mediocre. A machine foreman explained the centerline program:

> We want to tighten up on how we run the operation and that seems in conflict with the goals of the ETS. The thinking is that machines have a place where they run the best. People in each shift make a lot of changes based on where they think the machine runs best. We are trying to get away from that. On the other hand we are saying go use information and make changes. But we make it necessary for them to document change.

In the old environment managers had to debrief operators to document important cost-related data and communicate any changes to other shifts. The ETS now provided a more objective data base. It was easier to

share information across shifts than when conclusions had to be drawn from "old-timers'" experience. Operator reluctance to document and share information now stemmed from fear of "leaving a trail."

Loveman was adamant about the importance of documentation if there were to be changes in centerlines. He made that clear when he spoke with Adelman:

> I expect to see formal, written documentation by anyone who makes a process change. The printout from the ETS must be attached to the documentation.

Phillips summarized the dilemma as he saw it:

> A vacuum is created in this process. When managers impose centerlines of great detail, operators lose discretion. This means that managers have to step in to do analysis. Managers don't feel that operators are mature enough to have such discretion. Operators pull away because they feel they don't have enough discretion.

But had managers really "taken over" the system? Were the operators' complaints justified? Phillips offered another interpretation:

> Maybe we did too good a job of selling the ETS to operators as something that would be exclusively their tool. It is just possible that any input or thought about the ETS by management would have been seen by operators as interference.

The ETS usage varied by individuals and managerial level. Typically process engineers and crew foremen were 23-24 years old and came to the plant "right out of school." The process engineer's primary responsibility was paper machine quality tracking. The process engineer pointed out quality deviations to the machine foremen. Oswegan said:

> We (process engineers) are the ones who have the time for brainstorming. We don't get paid for making the changes, we get paid for coming up with ideas on how to improve the papermaking process.

Oswegan became an active user of ETS when operators "lost interest." Phillips explained:

> ETS was dead in the water after special project rules changed. Oswegan picked it up, dusted it off and said, "Hey, let's use it." He assumed the ETS advocacy role that Needham and Deutsch used to have. He used ETS and worked with operators to get them using it again.

Crew foremen were responsible for scheduling, training, crew development and day-to-day problem solving. Phillips said:

> Crew foremen are there for two years; operators have been there for twenty. Usually operators ignored crew foremen--before and after the ETS.

Two of the four crew foremen avoided the ETS. They "feared it . . . didn't understand it . . . wanted to see if it was a fad." Another crew foreman used it without operator assistance or involvement. Only one crew foreman, a former process engineer, worked with his crew to get the ETS information. He found that he relied on operator input and often deferred to operator suggestions. He said:

> I had fun digging into the system myself. It was an opportunity to work with operators in a nonthreatening, nonconventional role.

This crew foreman was pleased that operators could use the ETS to help solve day-to-day problems, but this also posed problems for him. He said:

> They did a wonderful job of training operators and elevating their technical competence. And they did an equally poor job of training us!

Many crew foremen were frustrated because without more knowledge of the ETS they were "less able to communicate with operators." They believed the lack of training would eventually hinder their professional development.

Machine foremen (promoted from crew foremen) were responsible for day-to-day machine operations (production and costs), and for integrating electrical, instrument, mechanical and operating activities. A crew foreman said, "If you want to do anything to the machine that day, you have to go to the machine foreman." Phillips talked about the machine foremen's response to the ETS:

> Even though they are accountable for all hard number data on the machines, they didn't jump on ETS. They didn't feel responsible for picking it up and running with it. They weren't trained on it, and they didn't use it. It was only after ETS had some success that they began to use the daily reports to help set machine goals.

Like the machine foremen, the general foreman did not use the ETS. However, he was forced to recognize its value because operators brought recommendations to him based on the ETS data. It was typical for operators to bypass the crew foreman and go directly to the general foreman because he had decision making authority on issues concerning longer term (6 months) planning--budgets, forecasts, troubleshooting and machine improvements.

The superintendent, Loveman, used the ETS data more than the general foreman. Phillips explained:

He'd ask operators to call up the data when he wanted to look at trends. He used the language of the data to communicate with and motivate operators.

In a speech to APC executives, Loveman described the changes in his role that were a direct result of the ETS:

> Now when I give daily tours I comment on costs in addition to production and safety. And I spend more time providing coaching and feedback to operators. I coach managers on skills--like how to influence, not control, operators. I talk to them about the expanding role of the operators. This coaching increased from about 10% of my time before the ETS to 30% of my time after the ETS.

Others saw the potential for role change as even more dramatic and less well understood. The general foreman said:

> We are all struggling for our turf. The technology will mean change in our social systems, but so far this social change in management is not orchestrated.

A crew foreman gave an example of how the technology poses a challenge to the managers' traditional role:

> Traditionally managers bring discipline to their organizations around centerlines, documentation, sharing information. Computers mean that that can be done without a manager. If we combine the computer with comments from operators, most of these things can be accomplished.

In considering the entire experience with the ETS, one operator with seventeen years in the company told Adelman:

> We are like reeds in the wind, and the extent to which we can do anything is determined by what kinds of pressures the managers exert.

DeWitt thought about the ETS experience and came to a similar conclusion:

> The company got less than what the operators were willing to give. . . We knew we needed the operators' buy-in and feeling of ownership. Our plans covered that well. But we really didn't think broadly enough. We didn't deal with the social change issues. We were so fixed on how we could save money.

Adelman's Reflection

Adelman had spent two weeks talking to people in the mill about the ETS. He recognized the conflict between the two management philosophies. One group wanted to provide the most sophisticated data possible to operators in order that those closest to the process have the

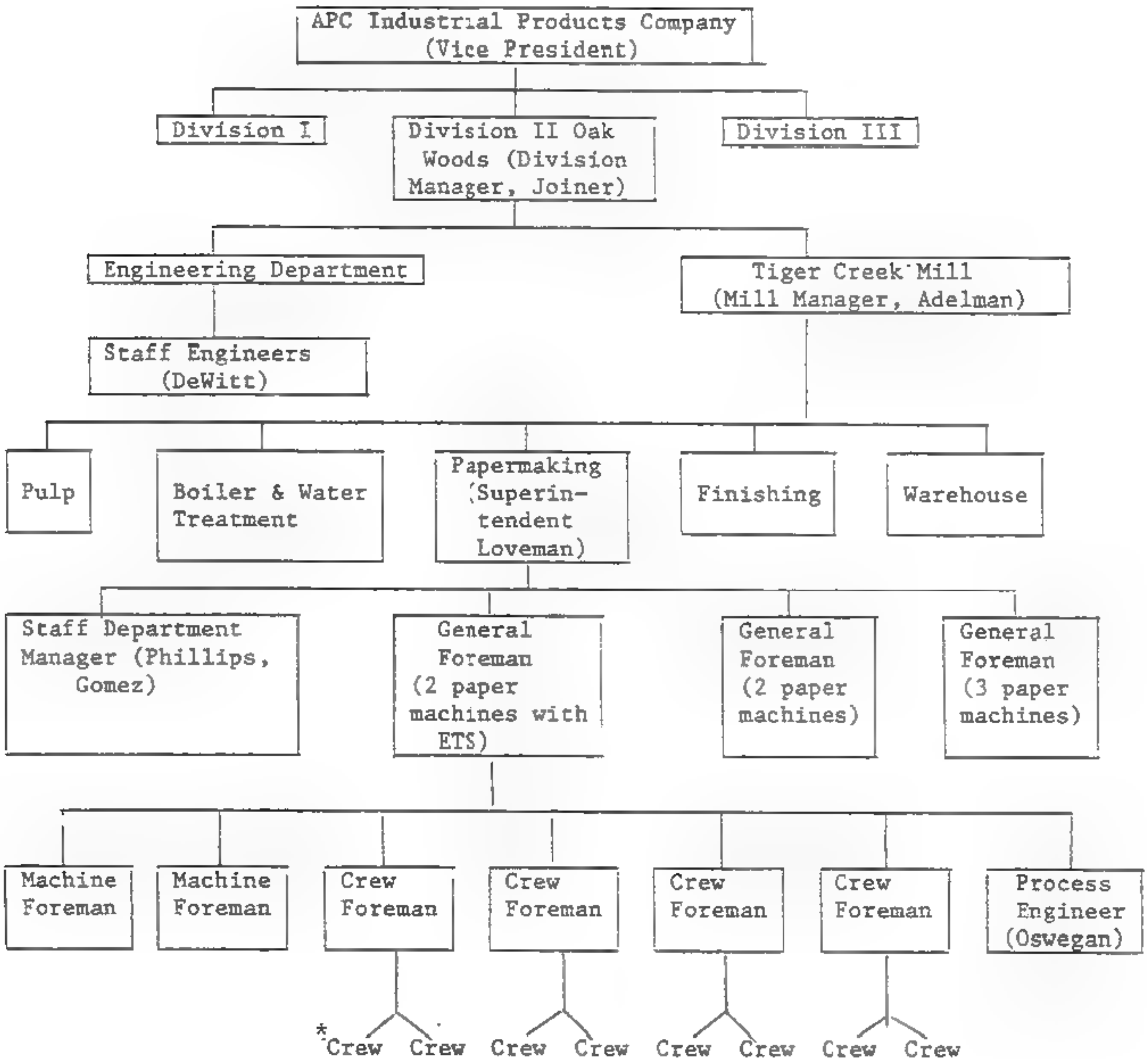
data for making decisions that furthered the business. The second group wanted management to use the data to establish and maintain optimum centerlines.

Adelman wondered whether operators or managers should receive and act on cost information? Which strategy would contribute the most significant long-range savings from the utilization of the ETS? Adelman sat back in his chair and thought:

> The people side is always the last thing that gets considered. It's the thing I know the least about. I can't really say what kind of people system I need to complement this new technology.

He knew that in one week he would be expected to have some answers for the VIPs who were coming to tour the mill. However, he realized that the presentation to the VIPs was only an immediate problem. The real challenge would be to tackle the broader organizational issues inherent in new information and control technologies. What organizational structure, roles, functions and skills would be appropriate in the conception of a new manufacturing organization, an organization in which advanced information and process control technologies would be even more prevalent. With plans being made to reapply the ETS concept on dozens of paper machines across the corporation, Adelman decided to use this presentation as a vehicle to call the VIPs' attention to the long-range issues.

Attachment A: Tiger Creek Organization Chart



*A crew consists of one Machine Tender, one Back Tender, and one Third Hand.

Attachment B: Paper Machine Crew Composition Job Descriptions

Machine Tender: This is the highest position in the operator hierarchy--the nonmanagement boss of the paper machine. Focus is on the center of the machine. Responsible for consistent formulation of paper (particularly moisture criterion), and for overall machine operation. Tasks include conducting laboratory tests, assuring that the machine is "behaving" and trouble-shooting. Spends the most time in a centralized control room.

Back Tender: Operate front-end of machine--furnish blending and sheet formation. (This part of the process is electrically controlled, and sensors extract the data.) Responsibilities include conducting laboratory tests and handling machine transfers; "lots of leg work."

Third Hand: Entry level position; "does whatever he's told . . . dirty work . . . the go-for." Focus on end of machine where paper is rolled. Responsible for conducting quality tests of paper and communicating results to machine tender. Spends more time directly interfacing with the process than do the other two levels of operators.

Attachment C: The Expense Tracking System Chronology of Events

1978	A system for monitoring energy costs is installed. DeWitt and Phillips develop the idea of a real-time expense tracking for operators.
1979	DeWitt and Phillips begin discussions of a "Production Expense Monitor." They begin documentation of cost factors for paper machines and involve other managers to help develop the concept.
1980	Six months of marketing "sells" the idea to Oak Woods Division managers.
	Presentation to corporate vice president wins high level support.
	Needham and Deutsch appointed to special projects.
1981	ETS design and special projects operator training.
1982 (March)	ETS is installed. Debugging and training continue.
1982 (November, December)	Managers begin using ETS.
1983 (January, February)	Increase in "bureaucracy" around ETS; new special project rules.
1983 (March)	One-year savings report is issued. ETS is declared a success.
1983 (September)	Adelman prepares for VIP tour.

Attachment D

I N T E R D E P A R T M E N T A L   C O R R E S P O N D E N C E

FROM: D. Oswegan, R. Samson, E. Gomez   DATE: January 31, 1983
TO: Distribution
SUBJECT: Expense Tracking Problem List

The following concerns have been identified as barriers that are keeping papermaking from utilizing the Expense Tracking System (ETS) to its fullest potential:

A. Data problems
B. Outages in user skills
C. User/computer interface problems
D. Implementation problems

Each concern area has specific elements for which a cause and solution is outlined in this report.

Data Problems

1. Actual consistency deviates from instrument consistency readings causing furnish costs to be inaccurate.

   Cause: Unsure. Consistency deviations could be caused by design fault of the controller, foreign objects in the furnish steam knocking the measuring devices out of calibration, or improper method of calibration.

   Solution: Interim solution is to check the consistency controller calibration on all stock flows once per two-weeks while instrument problem solving occurs. Long term frequency of checks will be developed as needed.

2. Averaged information when the machine is down is not useful to users.

   Cause: Software is set up so that costs go to zero when machine is down.

   Solution: To be determined by Project Team.

3. Some electrical elements show KW to increase when Amps decrease.

   Cause: Unsure. Could be field instrument problem.

   Solution: Will research to determine cause.

4. People are unsure of what to do when they suspect ETS has inaccurate data.

Cause: (A) Inadequate understanding of how ETS calculates its key variables. Solution will be discussed in qualification section.

(B) There is no system set up to gather input, track progress and publish results of "bad data" problems.

Solution: LHD will be responsible for working with KL to resolve any "bad data" items due to lingering software problems. Each P.E. is responsible for gathering the information for their machine.

(C) Operators unclear of procedures for when they notice an ETS problem.

Solution: Publish "boiled down" version of maintenance procedures for operators. Include this in the supplemental training guide and qualifications.

Outages in User Skills

1. People do not have sufficient user skills to be able to incorporate the ETS into their daily jobs.

Causes: (A) Performance-based qualifications have not been completed by operators and managers.

Solution: Agree on qualification format and execution plan (2/2)
Crew foremen qualified (2/11)
All persons qualified (2/25)

(B) Additional training material needs to be made available to adequately train people before qualifications.

Solution: Publish a supplementary training manual that includes specific section addressing each element of the performance based qualification.

(C) People don't understand how ETS calculates most of its key variables.

Solution: Include in the training manual a section showing how all the key variables for the ETS are calculated.

User/Computer Interface Problems

1. The location of the ETS makes it difficult to see the screen while using the keyboard.

   Cause: Inadequate placement of the ETS in the control rooms.

   Solution: One engineer and one operator resolve using PSU money.

2. Trending variables is difficult.

   Causes: (A) Outages in user skills. Solution discussed in qualifications section.

   (B) PV numbers are not easily obtained.

   Solution: Publish a listing of commonly used variables and their PV numbers, and make available near the ETS.

3. Creating graphs takes time.

   Solutions: (1) Designate 3 units to be for permanent graphs and build commonly used trend plots into them. Communicate expectations.

   (2) Set limits for graphs to be equal to high-high and low-low limits of alarming.

Implementation Problems

1. Cost reconciling does not occur in an effective manner.

   Causes: (A) Intent has not been clearly defined and communicated. Procedures need to be agreed upon.

   Solution: Develop an effective system to reconcile cost on a shift-by-shift basis in order to capture learnings due to cost swings.

   (B) Shift summaries don't print out at a convenient time and don't include targets and ranges.

   Solution: Match the needs of a cost reconciling system with the software capabilities of the report-writing system.

2. Alarm system is not being used.

   Cause: High and low ranges have not been determined for most variables. Procedures on how to use the alarms are not fully established.

   Solution: Have an ETS operator determine ranges, etc. in the values and rollout the use of alarms.

3. Savings documentation occurs infrequently.

Causes: (A) Operators don't have a clear understanding of the intent or procedures for documenting any tests.

Solution: Include a section in the supplemental training guide that explains the intent and procedures for documentation of any testing that includes the use of the ETS. Include in the qualification.

(B) Low visibility of results due to the ETS.

Solutions:
1. Include shift costs in Crew Foreman Log.
2. P.E. review testing results in biweekly letter.
3. Review previous day costs in morning meetings.
4. Track $/DAY in Machine Goals Review.
5. Publish project $ progress.

TECHNOLOGY

A BREAKTHROUGH IN AUTOMATING THE ASSEMBLY LINE

Allen-Bradley, a Milwaukee manufacturer of industrial controls, can run a computerized fact full tilt while turning out different versions of a product, even in lots of a single unit. Neit General Motors nor the Japanese have managed to do that yet. ■ *by Gene Bylin*

IT IS 7:30 A.M. on the eighth floor of an 80-year-old Allen-Bradley Inc. building on Milwaukee's South Side. Two-and-a-half hours ago, an IBM mainframe computer at the company's nearby headquarters relayed yesterday's orders to a master scheduling computer. Now, at the scheduling computer's command, what may be the world's most advanced assembly line comes to life with pneumatic sighs and birdlike whistles. Lights flash. Without human intervention, plastic casings the size of pocket transistor radios start marching through 26 complex automated assembly stations.

Bar code labels, computer-printed on the spot and pasted on each plastic casing by a mechanical arm, tell each station which of nearly 200 different parts to install in what combination. As the casings move along a conveyor belt, tiny mechanical fingers insert springs, another mechanical arm places covers over the casings, and automatic screwdrivers tighten the screws. At the end of the line a laser printer zaps detailed product information onto the side of each finished plastic box. The boxes are then packaged, sorted into customer orders, and shunted into chutes ready for shipment—all automatically. The four technicians who stand by to unclog jams are rarely needed. Elapsed time per box from start to finish: 45 minutes.

Allen-Bradley's specialty is industrial controls. The 600 units produced each hour on the automated assembly line are contactors and relays that serve as electromechanical starters and controllers for industrial electric motors. With this futuristic assembly line, which started up in April 1985, Allen-Bradley achieved a milestone in the development of computer-integrated manufacturing, CIM for short: the ability to make different versions of a product at mass-production speeds in lots as small as a single unit.

RESEARCH ASSOCIATE *Alicia Hills Moore*

Other companies can suit a customer's specialized needs on their assembly lines—Deere & Co. can tailor-make tractors, and General Motors can turn out automobiles with different engines and stereo equipment. But they cannot do it automatically without slowing down or stopping. No one else has achieved what John C. Rothwell, manager of the Allen-Bradley line, calls "the dream of the Japanese"—which is "to make goods flow like water through the line." To be sure, contactors and relays are not as complex as cars and farm machinery, but Allen-Bradley's remarkable assembly line points the way toward making more complicated products rapidly in lots of one.

Allen-Bradley is using its contactor line as a showcase for other products, particularly its so-called blue-collar computers that run machines on factory floors. Visitors, more than 2,000 so far, have streamed in to see the line and come away impressed. Allied Automotive, a Southfield, Michigan, division of Allied Signal, held four seminars for executives in Milwaukee last winter so they could see the Allen-Bradley line. "Our products are very different, but their concepts can be applied to almost any assembly operation," says George R. Seeger, director of technology planning at Allied Automotive. Says Charles Montpas, engineering supervisor of GM's AC Spark Plug division, "What they have is what we'd like to have in place."

Thanks to its automated line, Allen-Bradley has been able to come late to a highly competitive world market and establish itself as a leader. The company, which Rockwell International acquired last year for $1.6 billion in cash, had historically concentrated on the big U.S. market for industrial controls. Contactors and relays account for about 10% of Allen-Bradley's annual sales of $1.2 billion. But they are a crucial part of the other electrical equipment that Allen-Bradley sells.

Recent competition from Europe and Japan has changed the contactor and relay business. As the influx of industrial machinery from abroad intensified, so did the need for European contactors and relays. The contactors and relays in European and Japanese machines are generally one-third the size—and one-third the price—of those used in the U.S. The European-style devices, which meet standards set by the International Electrotechnical Commission (IEC), still make up a small market in the U.S., perhaps $100 million a year. The market elsewhere, however, amounts to about $700 million a year, and the IEC contactors and relays are fast becoming the world standard. Allen-Bradley made only the U.S. variety. The company faced a choice: either protect its core electric motor control business by making IEC contactors and relays or miss out on a growing market.

At first the company looked into offshore manufacturing, joint ventures, and making the IEC devices under license. Executives and engineers scoured the world to learn how such competitors as Telemecanique in France, Klöckner-Moeller in West Germany

and Mitsubishi in Japan made contactors and relays. Allen-Bradley decided against using cheap offshore labor because it discovered that supposedly low-cost manufacturing operations can be deceptive. An Allen-Bradley executive says that one Mexican plant pays assembly line workers only $1 an hour. However, because lack of automation means hiring many supporting workers such as warehousemen, total labor costs per assembly line worker run as high as $13 an hour—only $3 less than the rate, including benefits, of workers in Milwaukee.

EXECUTIVES FINALLY decided to invest $15 million in a new computer-integrated manufacturing line that they hoped would make IEC units at the lowest possible cost. Allen-Bradley says it could not employ traditional short-term return-on-investment calculations to justify the strategy because the company believed it was making a critical long-term decision. "If you're not going to be among the survivors," says Larry Yost, a vice president who led the automation effort, "ROI doesn't mean a damn." The financial calculation the company eventually used was return on assets, which it figured at 75% over the first eight years.

A team of nearly 30 engineers, technicians, accountants, and other specialists tackled the factory-of-the-future project. Even as the contactor and relay housings were being redesigned for ease of automated manufacture, engineers and technicians raced against a self-imposed deadline to develop the entire manufacturing process, including the assembly machines. Allen-Bradley wound up building 60% of the machinery itself. The rest came from outside suppliers.

The decision to make contactors and relays in lots of one if a customer so desired presented the biggest engineering challenge. "It was a mind blower," says Yost. "Nobody had ever done it before." The key was finding a way to identify the products being assembled so the line would not have to be stopped to make a different version. The Japanese *kanban* (just in time) technique uses serial numbers and special dummy objects to identify the start of a new batch. But that approach does not permit making lots of one at mass-production speeds.

The breakthrough came when engineers hit on using different bar codes to identify the various contactors and relays. Bar codes had been used in manufacturing to track parts in inventory, the way goods are monitored in supermarkets. In the Allen-Bradley arrangement, a bar code stands for the catalogue number of the device to be made and also serves as the label that tells all the machines on the assembly line exactly what operations to perform. Developing the bar code system meant finding a new way to formulate bar codes on the spot and print them as the contactor and relay shells moved by. Once the company engineers solved that problem with a specially adapted high-speed printer, "a lot of things fell into place," says Yost. The use of bar codes enables Allen-Bradley to make products in two sizes with 999 possible combinations of parts.

So contactors and relays of different sizes and types freely intermingle on Allen-Bradley's assembly line. Flexible assembly machines responding to specific bar codes make nearly instantaneous changes without slowing production. For example, when a bar code tells a screwdriver assembly that a larger contactor frame is approaching, the screwdriver moves upward and puts a larger screw higher on the frame. Occasionally, a bar code cannot be read properly because of poor printing or a defective label; when that happens, an alarm summons an attendant. That happens much less frequently than in supermarkets, where bar codes on packages are harder for a laser reader to track because they are often passed over it at an angle.

Scrutiny by scores of computer-controlled sensors helps ensure quality control. As a grinding machine processes the faces of tiny magnets for the controllers, for instance, a laser gauge measures the surfaces to keep them within tolerances as small as one-sixth the diameter of a human hair. In conventional manufacturing, magnets would have been first ground and then put into an inspection machine that culls the bad ones. Here there are no defective magnets. At Allen-Bradley, 3,500 automatic inspection steps have boosted product quality far beyond what less automated production can achieve.

Tracy O'Rourke, Allen-Bradley's president and chief executive, claims that no competitor anywhere can beat him on price or quality for IEC contactors and relays. One big user, impressed by the company's ability to deliver a finished product the next day, switched his business to Allen-Bradley from a European supplier. Depending on the competitiveness of the market, the going rate for one of the controllers produced on the innovative Allen-Bradley line is anywhere from $8 in Australia to $20 in the U.S. Allen-Bradley's cost is $6.42. Concedes an official of Square D Corp., Allen-Bradley's hometown rival, "Sure, they've scooped us with this line." Square D is not saying how much it spends to make a contactor. Allen-Bradley assumes it is more than $6.42.

TURNING OUT variegated products at will and with unheard-of speed also allows Allen-Bradley to do away with most of its parts inventory. The company manufactures everything it needs for the contactors and relays except springs, electrical coils, and screws. A local supplier delivers springs on a just-in-time basis. Screws and coils, ordered in economically large quantities, are stored until needed. The four technicians load assembly machines overnight with just enough raw materials and parts to take care of the next day's run.

Since Allen-Bradley did not make IEC contactors and relays before building the model assembly line, the company's major union, the United Electrical Workers, has raised no objections. "The process of automatic manufacturing creates more and more work for Allen-Bradley," says William Mollenhauer, chief steward of Milwaukee Local 1111. "Our job security will be stable because we will make the devices for that automation."

Allen-Bradley is now developing additional automated lines to make larger IEC contactors and relays. Some will be assembled by programmable robots. Says James J. Kinsella, division vice president and general manager of power products at Allen-Bradley, "We're No. 1 in all the markets we serve, and we intend to stay there." For U.S. companies, the Allen-Bradley lesson is that computer-integrated manufacturing provides an alternative to going offshore or going out of business. ◻

INVESTOR'S SNAPSHOT

ROCKWELL INTERNATIONAL

SALES (LATEST FOUR QUARTERS)	**$12.0 BILLION**
CHANGE FROM YEAR EARLIER	UP 18%
NET PROFIT	**$586.3 MILLION**
CHANGE	UP 3%
RETURN ON COMMON STOCKHOLDERS' EQUITY	**19%**
FIVE-YEAR AVERAGE	17%
RECENT SHARE PRICE	**$48.25**
PRICE/EARNINGS MULTIPLE	**12**
TOTAL RETURN TO INVESTORS (12 MONTHS TO 4/25)	**37%**
PRINCIPAL MARKET	**NYSE**

Explanatory notes: see Index

15

Phillips 66: Controlling a Company Through Crisis

In October 1988, Robert (Bob) Wallace, president of Phillips 66 Company, put the final touches on the statement he would read the next day announcing his retirement in compliance with the company's mandatory retirement age policy. Over the past four years, Wallace had led the company through a series of wrenching changes, as two hostile takeover bids left the parent company, Phillips Petroleum Corporation, struggling under an $8.8 billion debt load. Despite all that had been accomplished, Wallace recognized that a great deal still needed to be done to enable the company to survive and prosper in the future. He hoped his successor was up to the task.

Industry Background

In 1988, the petroleum industry[1] included four distinct vertical levels: production, refining, marketing, and transportation. ***Production*** involved the location and extraction of oil and natural gas from underground reservoirs. Although the U.S. crude production market was relatively unconcentrated by conventional measures, joint ventures in exploration and transportation and the merger and acquisition activities of the 1980s combined to produce the market dynamics of a concentrated industry. ***Refining*** manufactured finished products ranging from petrochemicals to motor and jet fuels. The 1980s had been characterized by significant excess refining capacity worldwide (see **Exhibit** 1). ***Wholesale and retail marketers*** distributed refined oil products to consumers. Most refining companies sold jet fuel directly to the Department of Defense and major commercial airlines; residential and motor fuels were distributed primarily through independent marketers. In the United States, there was substantial consolidation within the retail gasoline segment of the industry during the 1970s and 1980s, with the number of service stations decreasing from 216,000 in 1973 to 112,000 in 1988.[2] This decline reflected, in part, the replacement of small, independent stations by large "superstations." A specialized **transportation** industry that included pipelines, tankers, barges, and trucks moved crude oil from fields to refineries and finished product from refineries to markets. In the United States, pipelines, which were primarily owned and

[1]Material for this section of the case was drawn from: Martin, S., "The Petroleum Industry," *The Structure of American Industry*, 8th edition (New York: Macmillan, 1990), pp. 41-71; Yergin, D., *The Prize: The Epic Quest for Oil, Money, and Power* (New York: Simon & Schuster, 1991), p.773; and Sun, D., "Phillips Petroleum Company," *International Directory of Company Histories*, Vol. IV (Chicago: St. James Press, 1991), pp. 521-523.
[2]Martin, S. "The Petroleum Industry," p. 56.

Professor Lynda M. Applegate prepared this case with assistance from Research Associate Charles S. Osborn as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

operated by major U.S. oil firms, were the most important mode of transportation because they accommodated the movement of huge volumes of oil overland.

The world oil market during the decade following WWII was dominated by eight vertically integrated oil companies: Exxon, Texaco, Chevron, Mobil, Royal Dutch/Shell, British Petroleum, and Compagnie Francaise des Petroles. In 1950, these companies controlled 100% of world crude oil production outside North America and the Communist bloc; by 1970 they controlled slightly over 80%. This domination resulted from a network of joint ventures through which the companies shared ownership in four operating companies that controlled the flow of oil from Middle East oil fields: the Arabian-American Oil Company (Aramco), the Kuwait Oil Company, the Iranian Consortium, and the Iraq Petroleum Company. Although in violation of U.S. antitrust law, these joint ventures were permitted by the U.S. State Department for reasons of national security. "The seven companies controlled all the principal oil-producing areas outside the United States, all foreign refineries, patents, and refinery technology," reported Sampson. "They divided the world markets between them, and shared pipelines and tankers throughout the world."[3]

The joint ventures also led to a history of information sharing and cooperation that was uncharacteristic of industry competitors. Observed Martin: "Every major oil company was linked to practically every other one through a series of joint producing and refining ventures, long-term bulk purchasing agreements, and long-term reciprocal supply arrangements. Where joint facilities existed, they normally required joint operating decisions; the output of Aramco in Saudi Arabia, for instance, as well as that of the Iraq Petroleum Company, was partly determined by an intricate bargaining process among the majors."[4]

The September 1960 formation of the Organization of Petroleum Exporting Countries (OPEC), a consortium controlled by Middle East oil producers including Saudi Arabia, Iran, Iraq, and Kuwait, marked the beginning of efforts to end domination of the oil industry by the "majors." The balance of power over the next 13 years shifted toward OPEC. But, it was a radical, independent Libya that triggered a series of actions by other independents such as Algeria and, finally, Saudi Arabia and other OPEC countries to "nationalize" foreign oil interests. It was in this climate that the Arab oil embargo was imposed in reaction to Western support for Israel during the Egypt-Israeli War of 1973. Because of the length of time needed to develop new oil reserves, market forces were essentially the same during the second oil crisis in January 1979, which had been precipitated by the fall of the Shah of Iran (see **Exhibit 2**). During the 1980s, substantial oil reserves, developed by such Third World countries as China, Africa, Mexico, and South America, combined with decreased demand following a decade of conservation to erode the power of the OPEC cartel.

Company Background

In 1988, Phillips Petroleum[5] was one of the largest oil companies in the United States. *Fortune* magazine ranked it ninth in sales and tenth in profits in the petroleum refining industry and thirty-first in sales among all U.S. industrial firms.[6] In addition to its core businesses—crude oil and natural gas production, oil refining, and marketing of gasoline products—Phillips was also a leading producer of petrochemicals. Phillips 66, a wholly owned subsidiary of Phillips Petroleum Company, provided "downstream" (i.e., nonexploration and production) operations for

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[3]Sampson, A., *The Seven Sisters* (New York: Bantam Books, 1975), p. 147.
[4]Martin, S., "The Petroleum Industry," *The Structure of American Industry*, p. 44.
[5]Material for this section of the case was drawn from: Sun, D., "Phillips Petroleum Company," pp. 521-23, in *International Directory of Company Histories*, vol. 4 (Chicago: St. James Press, 1991).
[6]*Fortune*, April 24, 1989.

its parent. Phillips 66 engaged in six major lines of business: supply and transportation, crude oil refining, natural gas liquids, chemicals manufacturing, plastics production, and gasoline marketing. (**Exhibit 3** provides a financial summary.)

Named after its founders, Frank and L.E. Phillips, Phillips Petroleum was organized in 1917 to acquire its owners' original oil venture, Anchor Oil and Gas Company. During the first three decades of its existence, the company was highly profitable and earned a reputation as a leader in research and development. By the beginning of the 1950s, its natural gas and chemicals businesses were very strong, but it had begun to fall behind in oil exploration and production due to Frank Phillips' opposition to overseas ventures. Determined to keep Phillips a U.S. enterprise, Frank Phillips had declined an opportunity to join other U.S. majors in joint ventures in the Middle East. It was not until just prior to his death in 1950 that the company acquired a stake in Aramco.

During the 1950s and 1960s, Phillips Petroleum embarked on an aggressive program of capital investment to fuel a strategy of domestic and overseas growth and expansion. But, entering the 1970s, with signs of overexpansion and dwindling profits due to high capital costs, the company retrenched, instituting extensive planning and control systems to avoid the mistakes of the previous decades.

To ensure access to sufficient crude to supply its refining capacity and make it a "less attractive takeover candidate," Phillips launched in the early 1980s an aggressive series of acquisitions. In one acquisition, the company stepped in as a "white knight" to thwart Mesa LP's takeover attempt of General American Oil. This was not, however, the company's last encounter with Mesa and its chairman, T. Boone Pickens, who in late November 1984 announced his intention to try for a majority stake in Phillips Petroleum. The company, having anticipated such an action, fought back successfully at a cost of approximately $4.5 billion. But no sooner had Pickens retreated than Irwin Jacobs, Ivan Boesky, Carl Icahn, and other financiers began buying blocks of Phillips' stock. Icahn, with 5% of Phillips stock already, offered on February 12 to buy 45% of the company for $4.2 billion, which would give him a controlling interest. Icahn was paid off in March, at $62 per share compared with the $53 per share Pickens had received.[7] By May 1985, the company had sold off $2 billion worth of assets; debt levels peaked at $8.8 billion—an increase from 20% to 80% of equity (see **Exhibit 4**).

Controlling the Company Through Crisis

The task of rebuilding the battered Phillips Petroleum Company fell to C.J. (Pete) Silas, who succeeded William Douce as chairman in May 1985. Bob Wallace, president of Phillips 66, assumed the task for the downstream portion of the business. As Wallace contemplated the challenges he faced in managing downstream operations following the 1985 crisis, he defined the major areas that needed to be addressed:

> As I analyzed the situation right after the takeover attempts, it became clear that there were several things we needed to do immediately. First, we needed to streamline the business to enable us to dramatically increase our cash flow to fund day-to-day operations while servicing the huge debt. Second, senior management needed to become much more involved in the business. We needed to provide operating managers with a clear set of guidelines that would help them focus their efforts on the key leveraged parts of the business—the parts where we could make, or lose, money quickly. We had to monitor operations much more closely to ensure that we were operating at peak levels of efficiency and

[7]Sun, D., "Petroleum: Phillips Petroleum Company," p. 523.

> effectiveness. Before the takeover attempts, senior management operated on a 45-day reporting cycle; afterward, if we waited 45 days we could be out of business. Third, we had to break through the internal politics that had caused divisions to fight with each other more than with the competition. In 1985, our culture did not support collaboration and teamwork across divisions, despite high levels of interdependence. To survive, we would need to pull together and forget the constant bickering that wasted valuable time and energy. Finally, we didn't have time to slowly evolve a new organization and new way of doing business. We needed to turn on a dime.

At the time of the takeover attempt, Phillips 66 was organized into 14 divisions under two senior vice presidents in charge of the Petroleum Products (PPG) and Chemicals areas of the business (see **Exhibit 5**). The divisions were managed as independent profit centers, and a complex system of transfer pricing was employed to coordinate business processes that crossed organizational boundaries. In June 1985, Wallace reorganized downstream operations into nine divisions that reported directly to him (see **Exhibit 6**). The two senior vice presidents retired and six of the nine vice presidents were new to their positions. Below the vice president level, management and support staff were thinned by 40% and operating staff by 25%, the latter primarily through discontinued operations. On average, span of control doubled from five to nine or more.

"Prior to the 1970s," Wallace explained, "Phillips was structured as a centralized, functional hierarchy."

> But as we grew, senior management began to lose touch with the business. No longer able to keep track of the complexity of our operations, we began to lose control. In 1973, we brought in consultants who recommended that we decentralize decision making and reorganize around products rather than functions. We changed the structure and pushed decision making down, but realized afterwards that we didn't have the information we needed to run the business. Before the 1973 restructuring all information came from one source, the centralized corporate controller. Afterwards, operating managers requested their own controllers. At the same time, senior management, uncomfortable with losing control of the business, added staff. Between 1974 and 1978, we went from one controller to more than 30, and the number of staff tripled. We really hadn't decentralized decision-making authority. We had added *checkers to check the checkers*.
>
> The problem we faced after the attempted takeovers was how to restructure the company to operate in a much more focused and efficient way. We needed to cut costs and streamline the organization very quickly without losing control and without hampering our ability to operate effectively. To accomplish this I centralized decision-making authority and accountability for profitability and abolished the SBU concept and transfer pricing in our PPG business, which was highly interdependent by nature. I retained the SBU concept in the Chemicals and Plastics businesses, which were more independent. By eliminating the barriers to working together in PPG, I hoped to focus management attention on key leveraged areas of the business, to streamline management decision making, and to promote more of a "team" concept.

Once the centralization of authority needed to gain control was accomplished, Wallace decided to ***selectively*** decentralize decision-making authority and accountability for business decisions that were ***highly leveraged*** and had significant ***time value*** to enable the company to operate effectively and respond quickly. In the oil industry, such decisions centered on areas of pricing, supply, and trading.

A New Management Information and Control System

Wallace described his philosophy as he transferred decision rights and redesigned management information and control systems in the leaner Phillips 66:

> The problem facing senior management was how to transfer decision authority and accountability without losing control of the overall business. Drawing on the lessons we had learned in the 1970s, we wanted to provide operating managers with the information they needed to make decisions *before* we transferred authority and accountability. At the same time, we wanted to provide senior management with the information they needed to understand the business strategically. We did not want senior management looking over the shoulder of operating managers making operating decisions, but we did need to ensure that the company remained financially and operationally healthy.

The business information system that was developed to improve information sharing and communication is discussed in the next section.

Wallace went on to describe how he approached the decentralization of decision authority.

> Our first task was to analyze our current operating processes and the key decisions affecting them. Because of the debt pressure, we began with those decisions that had significant time value. In the oil industry, they centered on areas of pricing, inventory, and supply. For example, in 1985 Phillips faced market conditions that called for daily pricing decisions, but it usually took three to four days to change prices. If prices for motor fuel were off by a penny, it could mean a difference of as much as $40 million in annual profits. A similar mispricing of polyethylene could reduce annual profits by as much as $15 million. A penny in the oil industry is worth millions of dollars. We wanted to put pricing and inventory information and control in the hands of managers, who were in the best position to make those decisions on a daily basis. We developed a business information system to deliver that information to enable us to decentralize decision making.
>
> We then looked at our organization and identified the points of action and reaction with the marketplace. For example, for pricing decisions, that point was with our operating manager. For every point of action-reaction, there was also a point of control. Our next task was to identify that control point and change the role from active controller to monitor and teacher. In the pricing example, corporate staff used to set and control prices. As we passed decision rights down, these experts (fewer in number) would now serve, first and foremost, as teachers but also as monitors. At first, the front line managers made poor pricing decisions, despite access to improved information. Our approach was to work with them and give them a chance. If they were not able (or willing) to assume the increased responsibilities, we would pull them out. We were pleased that most of them quickly became better pricers than our centralized group.
>
> Our last task was to redesign our internal performance measurement and compensation systems to match the expanded set of responsibilities at all levels of the company. Prior to the restructuring, all 14 divisions operated as profit centers and we spent significant management time and energy resolving transfer pricing debates. But, as we attempted to control the company in the wake of the takeovers, it became clear that profitability was not the only criteria that we needed to consider. We needed to measure performance along a broad set of internal and

> external measures that corresponded to the diverse set of responsibilities that we were putting in place at all levels of the organization. As part of the reorganization, I asked all of the division managers to suggest criteria with which to measure the operating performance of their units. I then added my own criteria, and the combination became the basis for a new reporting system. Each division manager was instructed to cascade this approach to measuring performance down through the organization. We also recognized that quarterly reports would not be sufficient for controlling the more fast-paced, streamlined organization. To solve this problem, I instituted monthly responsibility statements in which all managers reported progress against performance criteria and revised performance measures as indicated This system improved our yearly planning and budgeting system by making the process more interactive and by enabling us to focus on the critical variables in the business.

Exhibit 7 summarizes structure and authority changes in the post-takeover restructuring. **Appendix A-4** contains a sample of the daily pricing information that was shared with operating managers through the on-line business information system to support the transfer of decision authority for pricing and redesign of the pricing process. **Appendix A-5** gives an example of a Phillips 66 inventory reporting display. The same information was shared with Wallace and the nine vice presidents. **Appendix A-6** presents a sample responsibility statement that was also shared on-line through the business information system.

Early on, Wallace recognized the importance of improved access to information and improved communication as critical tools for managing Phillips 66 through the crisis. Gene Batchelder, who assumed the position of Phillips 66 controller, recalled the effect that the Phillips 66 reorganization had on Wallace. "Everything that the senior vice presidents, staff analysts, and controllers had previously condensed, analyzed, and interpreted now reached Bob in raw form. He was learning of problems faster but was swamped with details." Many Phillips managers knew the story he told to illustrate his approach to management:

> During WWII, I was an antiaircraft gunner in the Navy. I used binoculars to sight enemy planes—sweeping all areas of the horizon, watching for evidence of incoming enemy fighters. At first I was overwhelmed by the vastness of the sky and the speed of the aircraft. My superiors taught me to take mental snapshots—glancing at different parts of the sky, looking for the specific characteristics that distinguished enemy planes from friendly ones.
>
> Managing Phillips 66 is very similar. There's simply too much information out there on the business horizon. We have to take snapshots of our operations and of world events. To do that we need rapid access to large quantities of information, condensed and reported in a manner that allows managers to quickly identify problems and opportunities. Since the business is changing quickly, the system needs to be flexible to adapt to the changes. In the Navy, access to that kind of information saved our lives. At Phillips, it saved our business.

In August 1985, Wallace met with Batchelder to discuss the use of a computer-based information system for Phillips 66 managers. He asked that the new system be implemented by the end of 1986.

Information Management at Phillips 66

Improved access to management information had been a major goal of Phillips Petroleum Corporation since the restructuring of the 1970s. In the late 1970s, an IT consulting firm was hired to benchmark the IT infrastructure and to make recommendations on improvements. Like many companies, Phillips had automated in the 1960s by creating specific applications to handle high-volume transactions. Over the years, as the company changed the way it did business, each specific application needed to be revised. Redundancy of information across systems resulted in inconsistency of data as revisions affected each application differently. High costs and long time frames were required to keep the inflexible systems up to date. As management information needs intensified in the 1970s, maintenance problems skyrocketed. The IT consultants recommended that Phillips adopt a database approach to information management, and a centralized database was created within Phillips Corporation headquarters that drew information from the inflexible applications and made it available to managers and staff through the use of a software package that enabled computer savvy analysts to customize their own reports.

Decentralized management information systems (MIS) units were set up within Phillips 66's Chemicals and PPG business units to work with the decentralized controller's units, which were called operations analysis and control units (OA&C). These two groups worked together to create customized and routine management information reports. Prior to the 1985 restructuring, Phillips 66's Chemicals and PPG SBUs had separate MIS and OA&C units, each reporting to separate managers. These four managers reported to the vice president of finance for each business unit, who in turn reported to the SBU head. With the reorganization, however, Wallace combined all four units (i.e., Chemicals MIS, Chemicals OA&C, PPG MIS, and PPG OA&C) into a single organization reporting to Gene Batchelder, who assumed the position of corporate controller and MIS head for all of Phillips 66. (The four previous managers retired.) There were about 25 employees in the newly combined department—about half as many as in its four predecessors. Batchelder had initially been tapped by Wallace to lead the combined MIS/OA&C function because of his broad background as a division controller within Chemicals and over 10 years of experience monitoring Phillips operations within both staff and line functions. He did not have formal MIS training, but had built a successful management reporting system within Chemicals using a personal computer spreadsheet package.

After the reorganization, the combined MIS/OA&C department initially assumed the same responsibilities. Recognizing, however, the need for more timely and flexible access to information as a result of the reorganization, responsibilities soon shifted to the development of an improved business information system, which was initially targeted toward meeting the needs of senior management and, as such, was referred to as the Executive Information System (EIS). The system was developed with the recognition that, as decision rights and control were transferred down, the system would need to be expanded to meet the information needs of those managers lower in the corporation.

Batchelder chose two managers to support him on the EIS project. B.J. (Bobby) Culpepper was hired from Corporate IS to provide information systems expertise. Culpepper had a BS in accounting and an MBA. He had worked for the local office of an accounting firm before coming to Phillips. At Phillips, he had six years of experience with Corporate IS in the corporation's Information Center and User Services Department. Batchelder selected Glenn Jones to provide operations analysis and control expertise. Jones had a master's degree in accounting and had worked at Phillips for eight years. In addition to having international experience, he had broad experience with providing management information to division executives.

In 1985, Batchelder, Culpepper, and Keith Bright, an IBM systems engineer, examined the available PC and mainframe hardware that could be used to run the EIS. Early in the process, they

realized that they would need the strengths of the mainframe and PC systems working together. As Culpepper and Bright described it:

> All the data we needed came from mainframe-based production systems and external databases. The mainframe could manage large volumes of data but was too cumbersome and slow for on-line data analysis and presentation to executives. We needed PCs for their ease of use, response time, flexibility, and capacity for executive-quality graphics.

FOCUS, which was already available on the mainframes, was used to access, integrate, and analyze the information for the EIS. But, the system still needed software that would create graphic displays of the information and store those displays for fast access by the senior managers. Batchelder and Culpepper worked closely with Keith Bright to locate software that met their specifications. After a long search, Bright found a demonstration software package, developed at IBM's laboratories in Hursley, England, that enabled the creation of sophisticated graphics. The graphics were created on the mainframe but stored and displayed on the PC. Bright and Culpepper then took on the task of rewriting the software program to meet the specifications of the EIS.

Glenn Jones and the OA&C analysts were responsible for providing the information for the system. Jones discussed their work:

> The OA&C analysts knew what information the managers were already seeing or wanted to see, and they knew where to find it. Wallace believed that the business divisions should be accountable for their data and maintain control of it. Therefore, we always went to the owner of the data that we wished to obtain. We reviewed how the data would be analyzed and displayed and requested permission to access it directly for the EIS. Although this could have been a sensitive issue, we found that Wallace's sponsorship of the project helped assure that we had the information we needed. If the sponsor of the EIS had been a vice president instead of the president, it would have been much more difficult.

By June 1986, the first fully operational version of the EIS was installed on Wallace's desk. By November 1986, workstations were on the desks of each of the division vice presidents and their executive secretaries. Shortly thereafter, the system was made available to managers who would be assuming responsibility for pricing and inventory decisions. Batchelder reflected:

> We developed and implemented the system in the time frame Bob Wallace established and within the cost and staffing restraints imposed by our financial condition at the time. We added no new mainframe software and built no new internal transaction systems. In other words, we leveraged off of the existing strengths and data we already possessed.

Managers used a keyboard to gain access to a series of information displays. These displays could include graphics, tables, and text. (Sample displays are presented in the **Appendix**.) Menus were used to organize the information in the system. The main menu, which could be customized for each manager, organized the information into 10 categories (see **Exhibit** 8). For example, "News, Quotes, and Highlights" provided a series of text-based screens containing daily news stories affecting the petroleum and chemicals industries, competitors, the parent company, and Phillips 66. The text was prepared by Glenda Fost, an information analyst who had worked with Phillips for many years and had broad experience in the operating divisions. Fost reviewed and summarized news stories from Dow Jones, Reuters, Platt's, and other oil industry data services. The text was updated three times a day: at 7:30 A.M., when most managers first arrived at work; at 11:00 A.M., before they went to lunch; and at 3:00 P.M., before they left the office for the day (see **Exhibit 9**). Fost described how she prepared the news summaries.

> I come in at 6:30 A.M., pull information, and publish the first news summary. Because of time-zone differences, that issue is mostly Far East and Middle East news. By 10:00 A.M., I have material on East Coast developments and by 2:00 P.M. I have the West Coast news.
>
> In general, the EIS allows our division managers to see the news highlights a day before they appear in the papers. A number of them now get all of their news information through the system, which can save them 30 to 45 minutes of reading time a day.

The "Weekly Operating Data" section of the EIS provided each manager with division-level operating information that was updated weekly. The "Monthly Letters" and "Responsibility Statements" sections were used by managers to inform the management team of its performance target and progress in meeting those criteria. The "Monthly Financial" section provided budget and financial information that was updated every month. Other selections provided key daily operating results. In addition to the information that the managers shared, each manager could specify a personal set of screen displays that other managers could not access. Selected personnel information and detailed operations information fell into this category.

Wallace and the senior managers were active in defining areas where they needed better or more timely information. Glenn Jones described how the process worked:

> In the beginning, the managers would tell us exactly what information they wanted and how they wanted to see it. Some would even go so far as to draw a sample of what the chart or graph should look like. As we became more experienced with identifying their information needs, and they gained confidence in our ability to provide the information in the most effective manner, they stopped telling us how to create the information displays and instead focused on explaining the problem area. Gene and I would discuss the problem and design a series of information displays that we thought would provide the information in the most effective and efficient manner. We would show the sample displays to Wallace or the manager who had requested them and then revise them until we had captured what was needed. Sometimes a manager would say, "I think that's right. Go ahead and build that for me and I will let you know how it works." I would then go to the OA&C analysts and have them track down the information and build the display. It usually took us about one to two days to build a new display from the time that the manager made the request to the time that he or she had the display on his or her machine. Often we would not create the electronic links to the data until the manager had used the display and was satisfied that it presented the proper information in the proper format. Instead we would manually update the information until we were sure we had a workable set of displays.

The EIS was linked directly to PROFS—IBM's Professional Office System. Managers used the electronic mail function of PROFS to communicate with other Phillips employees worldwide. PROFS also provided electronic calendars for individual managers, conference room scheduling services, and other managerial productivity tools. The EIS provided meeting agendas, meeting minutes, and copies of meeting presentations for all formal meetings.

At Wallace's suggestion, Batchelder and Culpepper set up a conference room to enable use of EIS displays at meetings. The room had a wall-sized projection screen, a concealed workstation that ran the EIS from a keyboard at the head of the conference table, and other video and audio capabilities. "We designed the room for large-screen presentations," Batchelder explained.

> Over time, however, it's become the "EIS meeting center." Wallace started holding his monthly coordination meetings there, using EIS displays rather than sending out for 35mm slides. Now he uses it for most of his periodic meetings, including all of his staff meetings. Other division managers also use it for their staff meetings. Presentation materials and meeting minutes can be circulated on the EIS before and after each meeting.

Introducing EIS to the Division Managers

Wallace played a pivotal role in managing the adoption and growth of the system. By his example and encouragement, he kept the EIS project responsive, visible, and on schedule. Batchelder recalled events from June to December 1986:

> In June 1986, Bob was using his EIS workstation several times each day. He insisted that each vice president have an EIS workstation in his or her office, but he did not demand it be used. He allowed each manager to design a customized cabinet to house the workstation that fit with his or her office decor. He wanted each one of them to feel comfortable with it. Above all, he wanted each of the vice presidents to assume ownership of the system. When I suggested that we strongly encourage managers and analysts to support the system, Bob said to go slowly: "Now that they have the workstation, let's not bother them for awhile. They'll adjust to it, and soon they'll come to us." Bob did, however, inform the vice presidents that his meeting schedules and calendar would now be on PROFS and that he would be communicating with them using electronic mail. Bob was right. When the vice presidents saw how well he was prepared for meetings, they also began to ask us for customized information displays. We noticed that the sharing of information through the EIS drastically decreased the amount of discussion during meetings over whose numbers were correct. After a few weeks, Bob met with the vice presidents to discuss information that they wished to view in common.

Batchelder discovered that three vice presidents were eager to have the system, three were generally indifferent, and three cautious. One of the last three was actively opposed to the system. Ben Jones, vice president of Planning and Budgeting, already had a sophisticated manual information system in place. He initially saw no need for the system. Soon after the EIS was introduced, however, Jones underwent back surgery and was forced to recuperate at home for almost eight weeks. At his request, Culpepper and Bright delivered an EIS workstation to his home and showed him how to use it to stay in touch with the office. When Jones returned, he became one of the EIS's strongest supporters.

In December 1986, the EIS provided 50 reports and graphs and was running on the Corporate mainframe along with many other IS applications. By January 1987, the increasing load of FOCUS and PROFS use throughout the company overloaded the mainframe. EIS performance decreased—an occurrence that was immediately noticed by Phillips 66 managers, who asked Corporate IS for a mainframe system with more power. Batchelder noted how the relationship between IS and the line operations had changed:

> EIS usage subtly changed the relationship between Corporate IS and our managers. This was the first instance where the *managers* had requested better computer performance. Before that, the executives usually demanded that IS cost-justify and explain in detail the need for computer upgrades. But in this case, Wallace himself documented the need for the new machine to the Corporate Executive Committee.

The commitment of senior management to expanding the use of technology was also apparent in other areas of the company. During a second wave of cost reductions that followed a drop in oil prices in late 1986 and 1987, the company's spending for IS actually increased. This went against industry trends. Art Wilson, Phillips's IBM account manager who worked with a number of the major oil companies at the time, explained:

> In the oil industry, most companies spend money on IS when times are good and cut back drastically when they're bad. Phillips 66 made a strategic decision to do just the opposite. It is using computer systems to drive a cost-reduction strategy. For example, in late 1987 Phillips 66 decided to cut costs by closing several marketing districts. Even so, it did not want to cut its overall marketing effectiveness. In fact, it wanted to improve it. So, while Phillips 66 reduced marketing and sales staff, it added a sales and marketing information system to enable fewer people to cover wider areas more effectively.

By January 1988, the EIS contained over 1,000 information displays for 45 managers and 35 secretaries and staff. Wallace continued to personally approve each new EIS installation to help monitor and manage the growth of the system. Many managers had EIS workstations at the office and at home. More than 1,200 staff analysts and IS professional were using FOCUS, and PROFS users exceeded 5,000.

Use of EIS by Phillips 66 Managers

Wallace and his management team used the EIS to redesign key business processes and create a more interactive and time sensitive management control system. One EIS screen, for example, had resulted in tighter control of Phillips 66 inventories. Batchelder recalled this improvement:

> Inventory control was a constant theme in management meetings, but individual managers found it very difficult to estimate their current inventory positions. Understanding 12-month trends in motor fuel inventory levels required the compilation of some 24 spreadsheet reports, which were seldom available at the same time or in the same place. A manager would learn of May inventory levels at the beginning of July. Even with motor fuel inventories set at 9.5 million barrels, we often had outages.
>
> This situation changed after we distributed an EIS display, updated weekly, that described current inventory levels. The display synthesized the information from the 24 spreadsheet reports and allowed an immediate comparison of current and past-year levels with a target-inventory range. This information is now available to the operating managers responsible for inventory control. Since they began using this display, we have been able to decrease motor fuel inventories to 8.5 million barrels. At about $18 a barrel, that represents a sizable amount of money.

Charlie Bowerman, vice president of the Marketing Division, used the EIS one to two hours each day to better monitor market conditions and more efficiently measure the impact of pricing changes:

> Marketing negotiates three-year sales contracts with motor fuel distributors, but actual sales fluctuate daily in response to customer needs and changing market conditions. The EIS has made us much more responsive to both

> these critical factors, with the results being significantly improved inventory, supply, and pricing management. Conservatively, the system has generated increased profits of $20 million.

Dick Robinson, vice president of the Refining Division, used the system for more than one hour per day during short sessions spread throughout the day. He estimated that EIS access reduced the amount of mail passing through his office by 50%. He also noted how the system contributed to monitoring his business:

> In December 1986, I uncovered a potential scheduling problem at the Borger refinery during my daily check of division news on the EIS. Division engineers were planning to shut down one of the crude oil processing units, called a Heavy Oil Cracker, for 10 days. This cracking unit converted raw crude oil into products such as motor fuel. The engineers wanted to overhaul the cracker to bring efficiency back up. They were unaware, however, that motor fuel demand was exceeding Phillips' production capacity. Bringing the cracker down would force the company to purchase motor fuel for resale at a lower margin on the spot market. I contacted Borger directly and asked for a catalyst retest. The results were in a range that convinced the engineers it would be safe to postpone catalyst replacement until a general plant overhaul scheduled for the spring of 1987. Operating the cracker for the 10 days that it would have been idled allowed us to produce 337,000 more barrels of motor fuel than had been budgeted, resulting in higher profits and an overall cost saving estimated at $650,000. Soon after, we provided the refinery managers with the information needed to help them recognize these difficulties as they made scheduling decisions. We have found other areas like this where we were unaware that operating managers did not have sufficient information to manage the business.

A few months after the initial implementation, Batchelder surveyed the division vice presidents and found that most used the EIS daily when they were in town. During their frequent travels, many used laptop computers or received EIS reports from their secretaries. Chemicals' vice president Jack Howe used the EIS to scan news and quotes for 10 minutes two to three times per day. Howe and six of his seven managers were new to their jobs in 1986 and felt that the EIS was a valuable tool for quickly gaining experience with the Chemicals Division's business. Ray Steiner, vice president of Supply and Transportation, had a Reuters terminal in his office before the EIS was installed. Now he used the EIS as well; it was the first thing he turned to every morning.

Wayne Anderson, newly promoted vice president of Natural Gas Liquids, used his previous experience in the Marketing Division to significantly expand the computerization of the NGL Division:

> Access to the information in the EIS is changing the way we run the business. For example, LP gas is now priced at each of our 82 individual pipeline terminals. This allows our front-line managers to assume control of the pricing activity and allows us to respond much more quickly to changes in specific markets. Before, we had a much more centralized approach to pricing and only set prices for the three large pipeline systems that we operate. Customers feel that Phillips 66 is more responsive, and our competitors seem to be confused by the new pricing structure. They are having trouble reacting.

Batchelder described the system's use by Gail Anderson, vice president of Human Resources:

> Gail has used the EIS as a driver to implement changes in the availability and use of individual employee and organizational information. His leadership

has moved personnel data out of the confines of the large, corporately administered database and into the hands of our executives and line managers.

The Plastics Division represented a unique use of the EIS. Plastics' vice president, John VanBuskirk, had developed an on-line information reporting system for his area before the EIS was introduced. Because of the specialty nature of his business, the original data in the EIS were not of great use to him. VanBuskirk ran a collection of distinct businesses, ranging from fibers to plastic pipe and high-technology composites. These dissimilar businesses were alike only in that they often served the same customer. VanBuskirk needed information that treated his businesses by market and customer rather than on the temporal basis used by the EIS. Batchelder, Jones, and Culpepper worked with VanBuskirk and his managers until they had completed a full-scale EIS tailored to Plastics. VanBuskirk could still gain access to displays shared by the other division vice presidents, but his workstation was so fully customized that it appeared to be a different system.

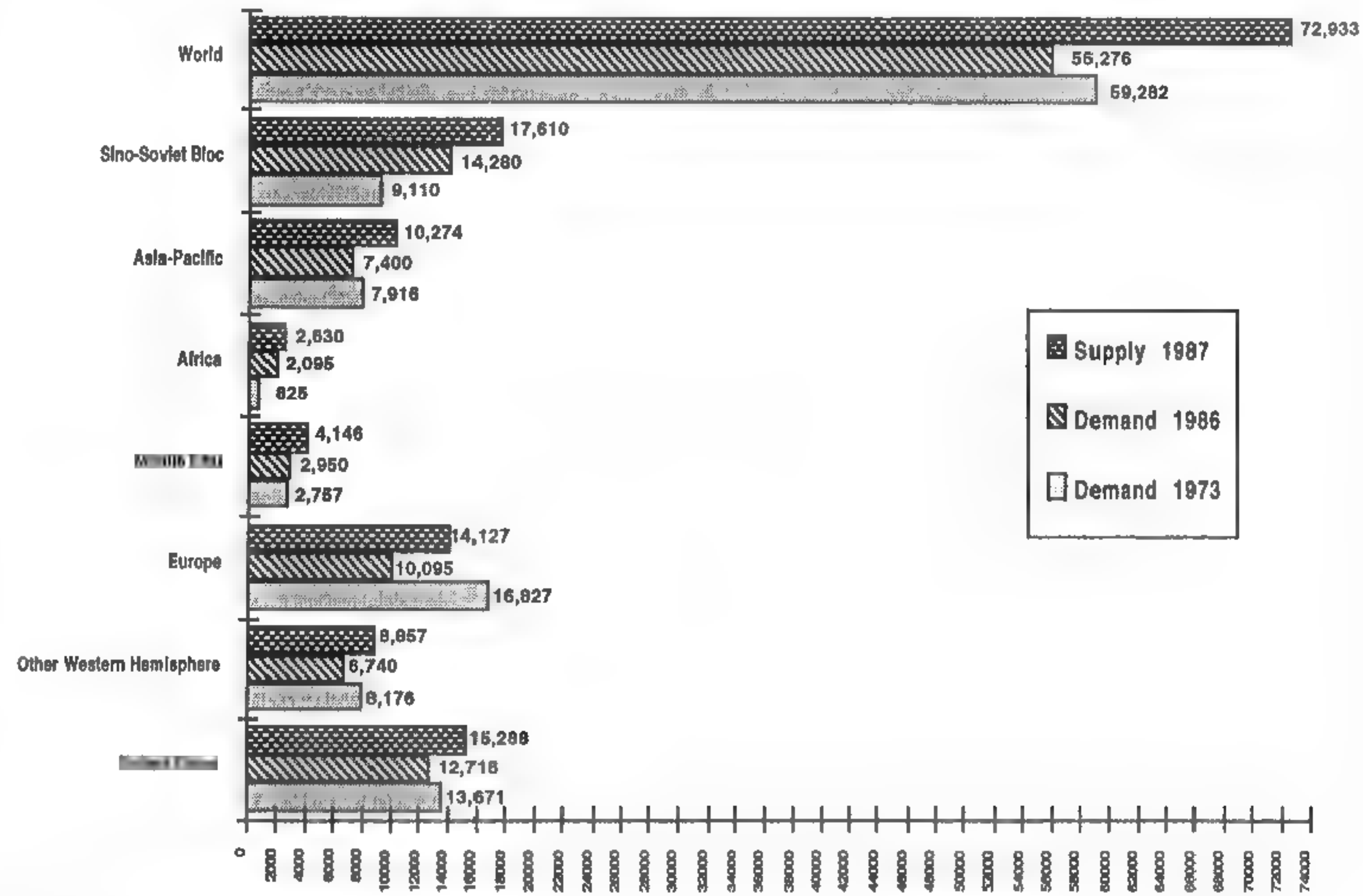
Where To From Here?

By late 1988, Phillips Petroleum Corporation appeared to be bouncing back despite sagging oil prices. A *Business Week* article reported that "[Phillips's] salvation came from a stunning 1988 performance from downstream operations. . . . They generated $1.3 billion in cash and enabled Phillips to make a $900 million debt payment. As a result, the company's average yearly payments dropped to a manageable $332 million, although it still faced a $939 million payment in 1995."[8]

After Wallace finished the statement announcing his retirement, he took a clean sheet of paper and began to jot down issues that he wished to discuss with his successor, Bill Thompson. Like Wallace, Thompson had spent most of his career at Phillips. But, unlike Wallace, he had worked primarily in the "upstream" (exploration and production) side of the business. In addition, Thompson had openly questioned Wallace's decision to centralize P&L authority and to implement the EIS to help manage the company through the takeover crisis.

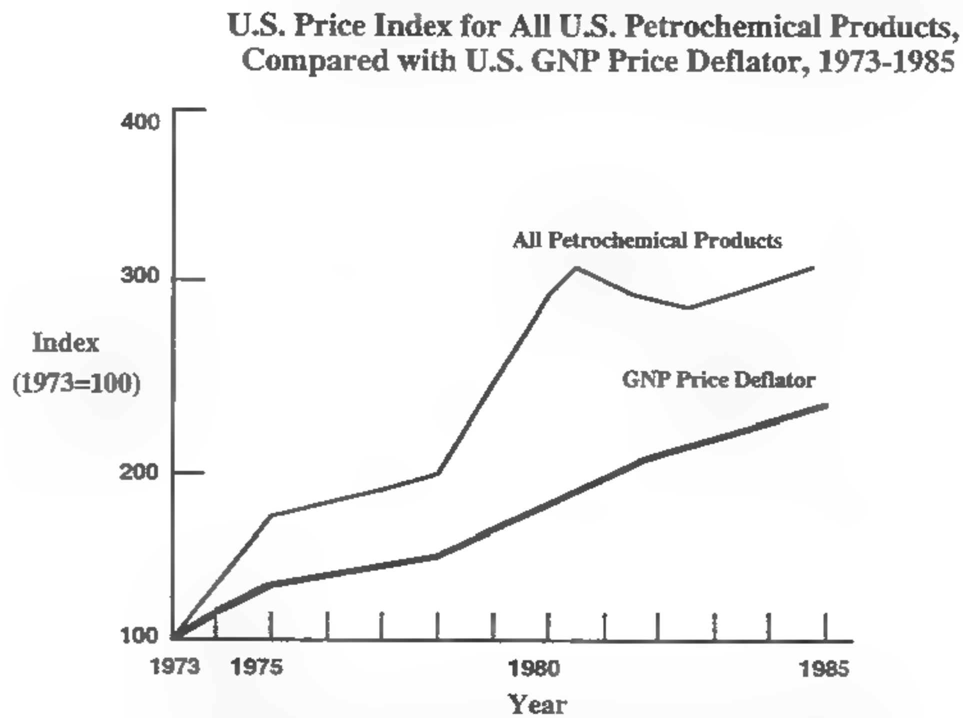
[8]Phillips Climbs up from the Bottom of the Barrel," *Business Week*, January 16, 1989.

Exhibit 1 Worldwide Petroleum Refining Capacity and Demand (thousand barrels)

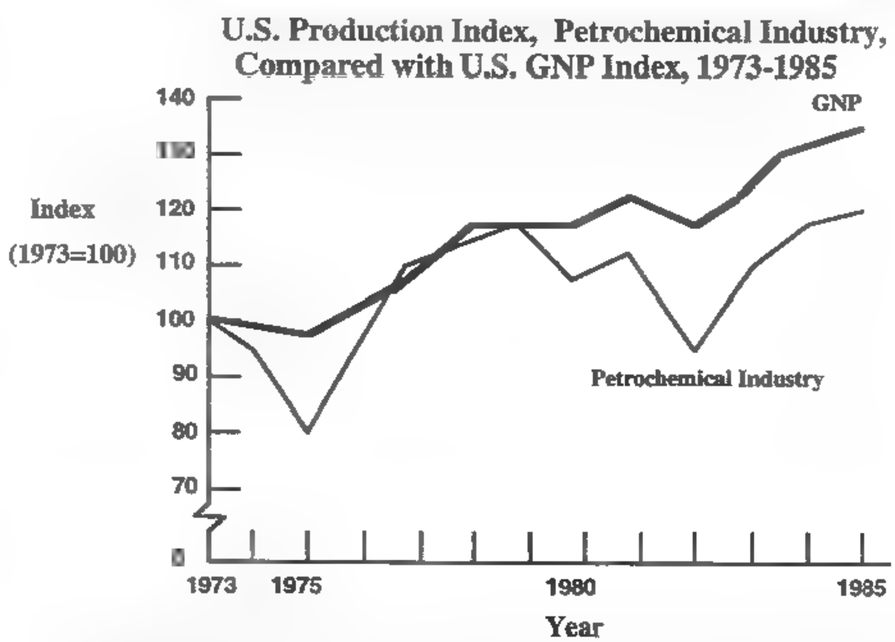


*Data were drawn from the *Basic Petroleum Data Book*, Volume VIII, Number 2, May 1988, published by the American Petroleum Institute.

Exhibit 2 Petroleum Industry Price and Production Trends (1973-1985)



Source: US Department of Commerce, *US Industrial Outlook* (Washington, DC: GPO), 1986, p.11-2 & 1987, p.11-4.



Note: GNP is in constant dollars.

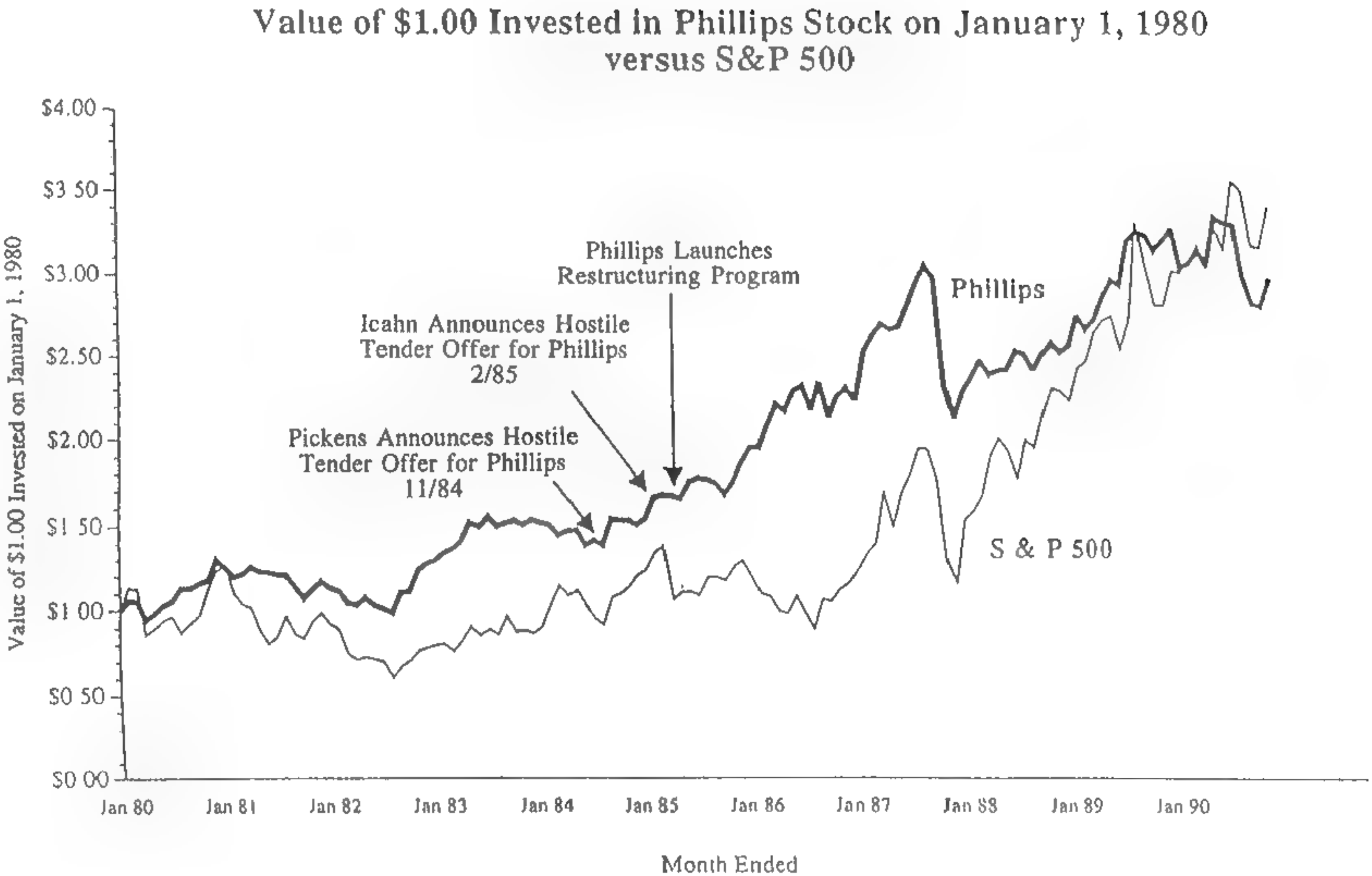
Sources: US Department of Commerce, US Industrial Outlook (Washington, DC: GPO), 1986, p.11-2 & 1987, p. 11-4.

Exhibit 3 Selected Financial Results ($ in millions)

	1980	1983	1984	1985	1986*	1987*	1988
Phillips Petroleum Co.:							
Total Revenues	$13,712	$15,411	$15,756	$15,800	$10,015	$10,917	$11,490
Net Income	1,069	721	810	418	228	35	650
Capital Expenditures	1,666	1,141	1,387	1,060	655	750	797
Total Assets	9,844	13,094	16,965	14,045	12,399	12,111	11,968
Phillips 66:							
Net Income							
Petroleum Products	79	86	97	170	300	130	312
Chemicals	122	40	128	128	210	260	595
Capital Expenditures							
Petroleum Products	336	126	109	95	75	131	177
Chemicals	181	64	77	45	46	78	130
Total Assets							
Petroleum Products	NA	NA	3,133	2,774	2,500	2,643	2,707
Chemicals	NA	NA	1,498	1,315	1,053	1,165	1,349
Key Pet. Products Sold thous. barrels per day							
Auto gasoline	214	212	218	239	243	256	245
Aviation fuels	19	23	26	31	31	32	36
Distillates	81	81	82	91	93	98	100
Chemical Sales thousands of pounds							
Ethylene	NA	539	481	812	803	903	720
Polyethylene	NA	1,254	1,358	1,508	1,410	1,606	1,585

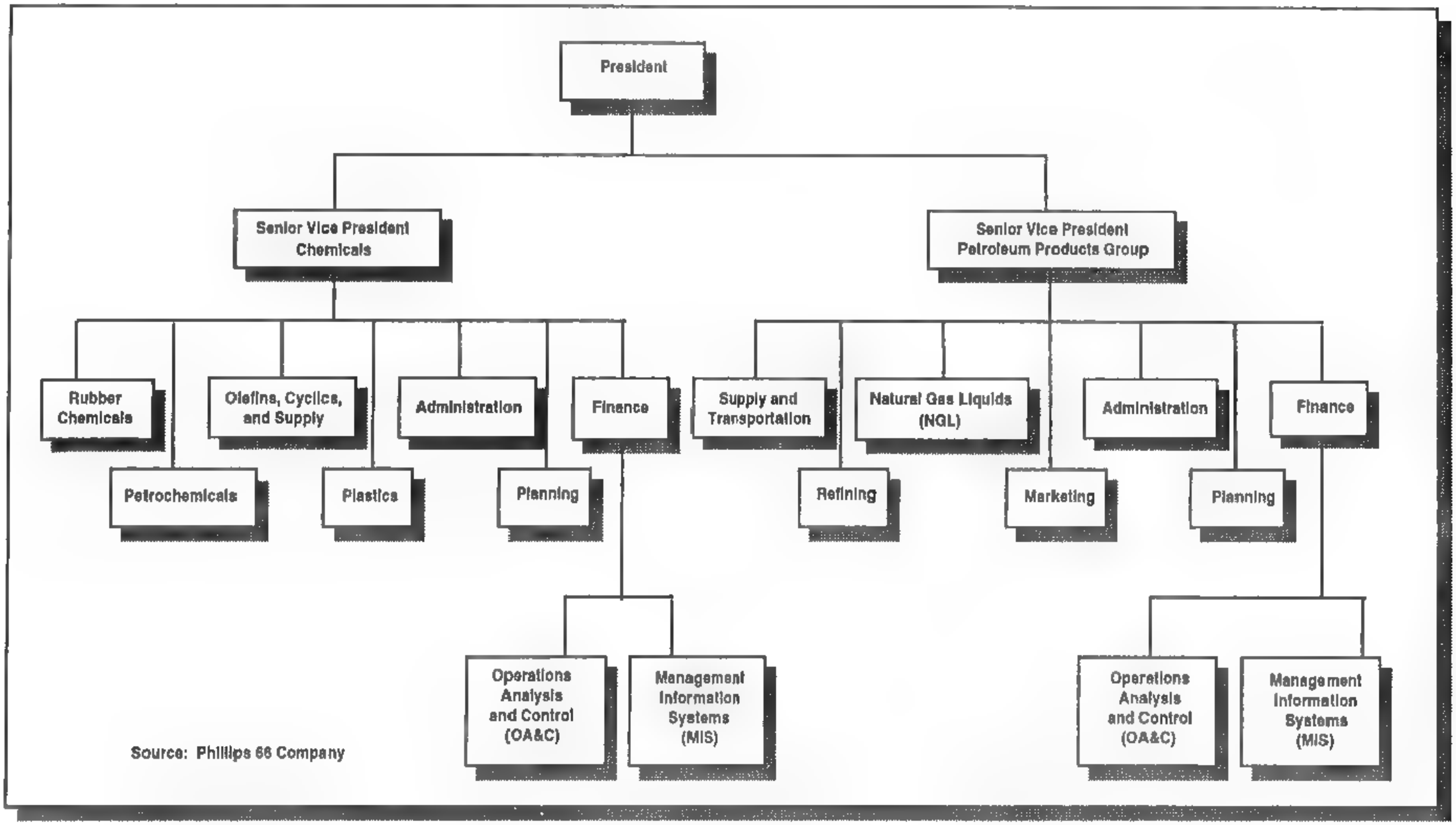
* Net income not available for these years. Listed figures are estimates based on operating profit.

Exhibit 4 Phillips Stock Prices vs. S & P 500, 1980-1988



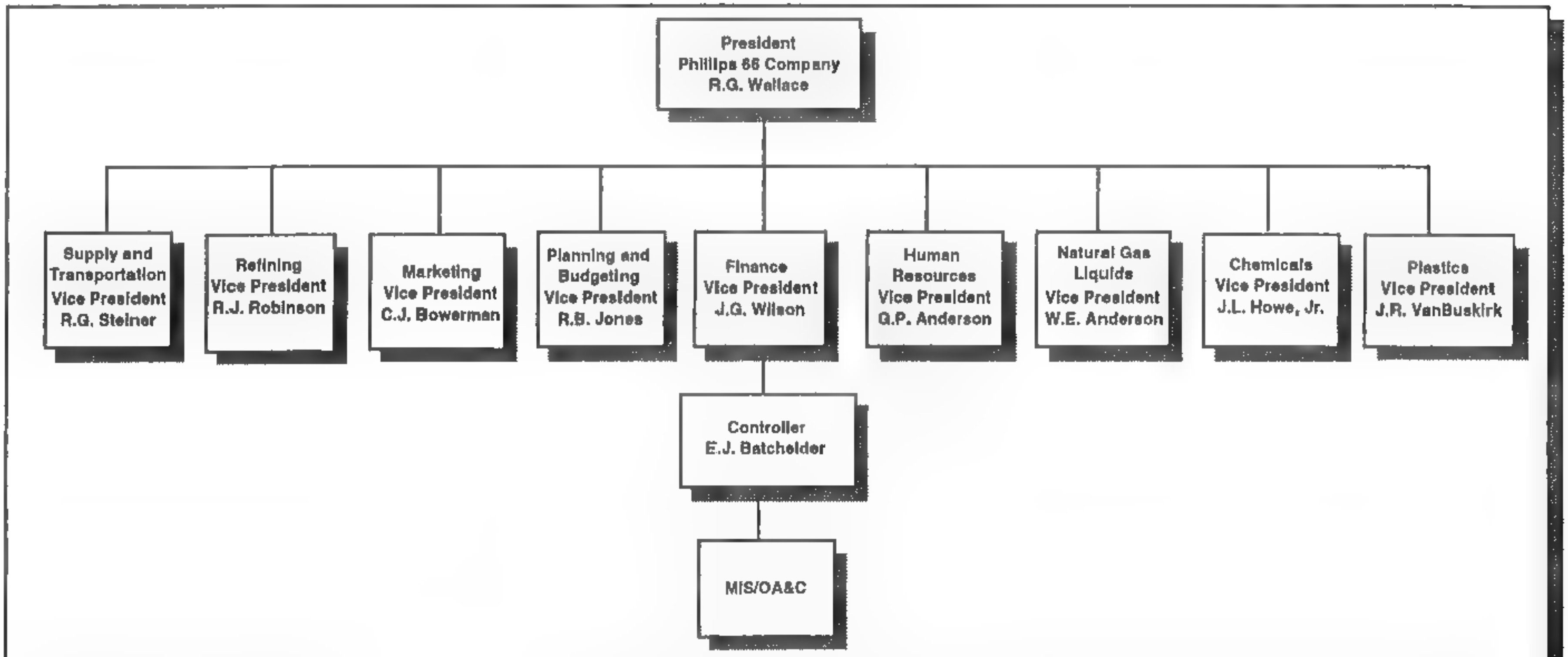
Source: This exhibit was prepared by Professor Karen Wruck of the Harvard Business School

Exhibit 5 Phillips 66 Organization Chart Prior to May 1985



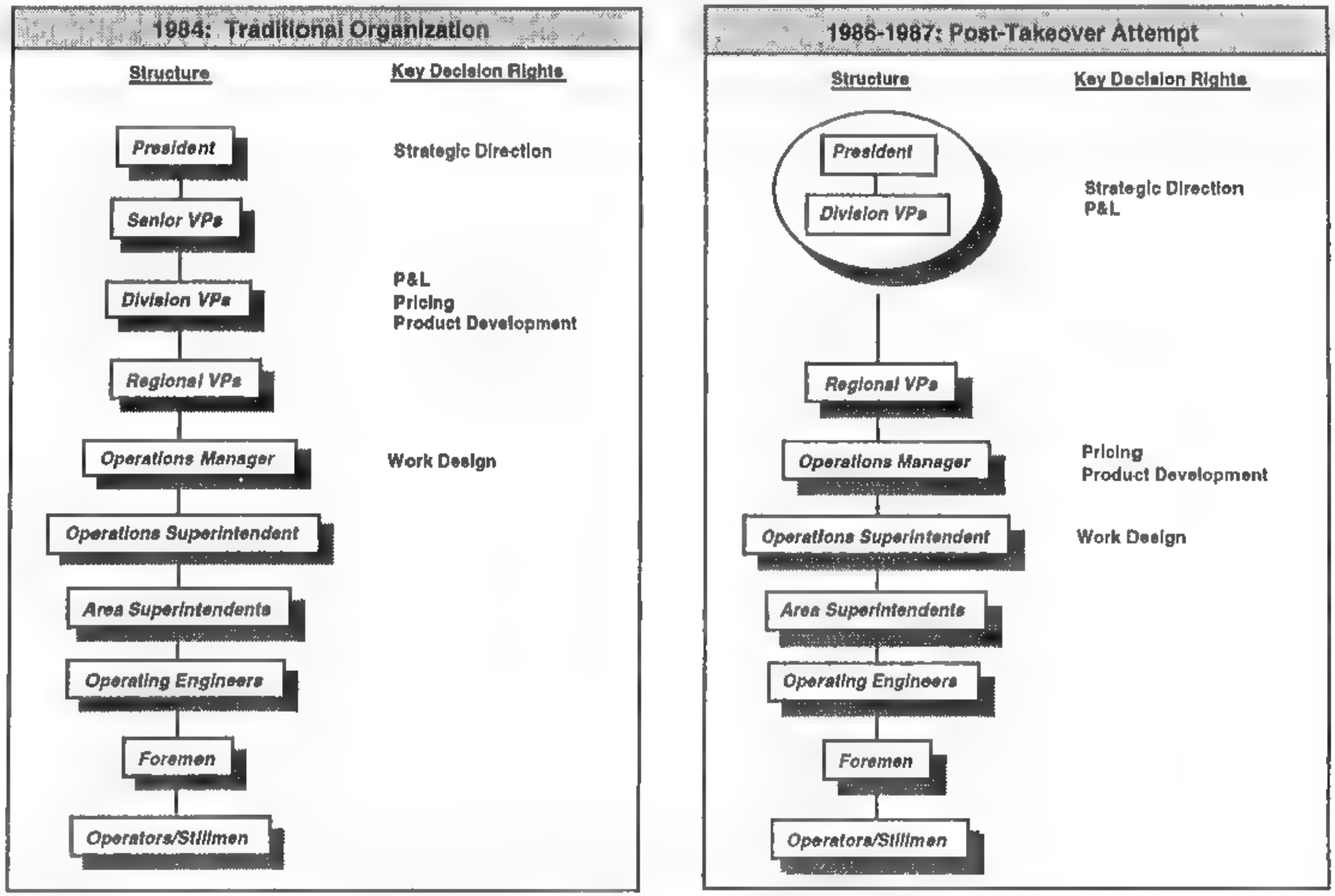
Source: Phillips 66 Company

Exhibit 6 Phillips 66 Organization Chart as of June 1, 1985



Source: Phillips 66 Company

Exhibit 7 Summary of Structural Changes at Phillips 66, 1984-1988



Note: Circle indicates team-based units; squares indicate hierarchical units.

Exhibit 8 EIS Main Menu

Phillips 66/EIS **Main Selection Menu** **07/07/88 9:08AM.**

Type number and press ENTER →

1.	**News, Quotes and Highlights**	**6.**	**R.G. Wallace Personal Info**
2.	**Weekly Operating Data**	**7.**	**Forecasts and Trends**
3.	**Monthly Letters**	**8.**	**Administration**
4.	**Responsibility Statements**	**9.**	**File Control**
5.	**Monthly Financial**	**10.**	**Conference Room Meetings**

Function Key Assistance

F1 - Print Profs Note **F5 - Other Printing** **F2 - Esc to Introduction**

Source: Phillips 66 Company

Exhibit 9 News Summary

Highlights Edited by Phillips 66/MIS from Dow, Reuters, Platts & Other Sources

05/16/88 - Chemicals/Plastics

7:30AM Highlights

Reuters Rome

ENI says Enicher unit signed Letter of Intent w/China Hainon Petrochem General that could lead to construction of major petrochem complex on island of Hainan. . . . project cost undisclosed/sources close to ENI say it could involve $800 mln investment. . . . ENI says accord covered possibility of creating joint venture w/China group to construct complex, which would include 250,000 tonne naphtha cracker plus PE/PP/butadiene prods plants. . . . Snamprogetti unit/Technipetrol to carry out feasibility studies to evaluate project economic & industrial viability.

Reuters Rome

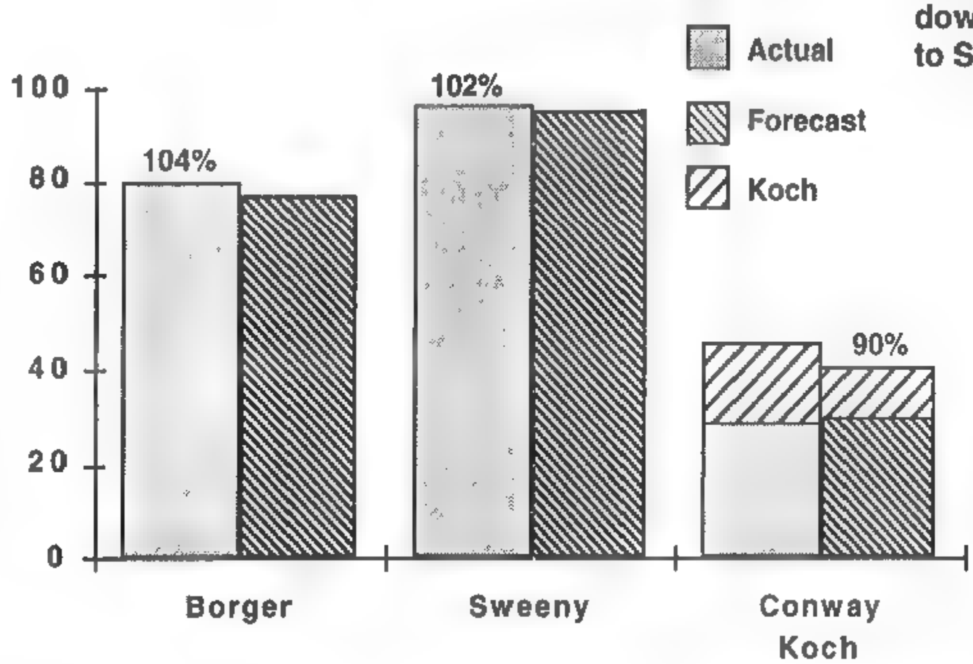
ENI says Super Octanos, joint venture w/Pequivan, signed $150 mln finance accord for Jose petrochem complex to be built by Super Octanos near Puerto La Cruz. . . .due to be completed in 3 yrs, will produce 500,000 tonnes/yr MTBE high octane prod which allows lead compounds to be eliminated fm gasoline, financing, organized by Manufacturers Hanover/ involving 22-bank intl consortium, comprised $70 mln export credit & $90 mln medium-term loan. . . . total project cost expected to be $266 mln. . . . ENI participates in Super Octanos thru Ecofuel sub/Pequivan is PDVSA unit.

* PRINT - Print	PF8 - Page Forward
PF7 - Page Backward	PF12 - Quit

Source: Phillips 66 Company

Appendix

Exhibit A-1 Natural Gas Operation



NGL production continues to run ahead of forecast. Sweeny fractionator NGL charge levels are currently limited by NGL availability. A leak on the E/Z pipeline has resulted in unscheduled downtime, resulting in limited deliveries to Sweeny.

Exhibit A-2 Plastics' Capital Budgeting

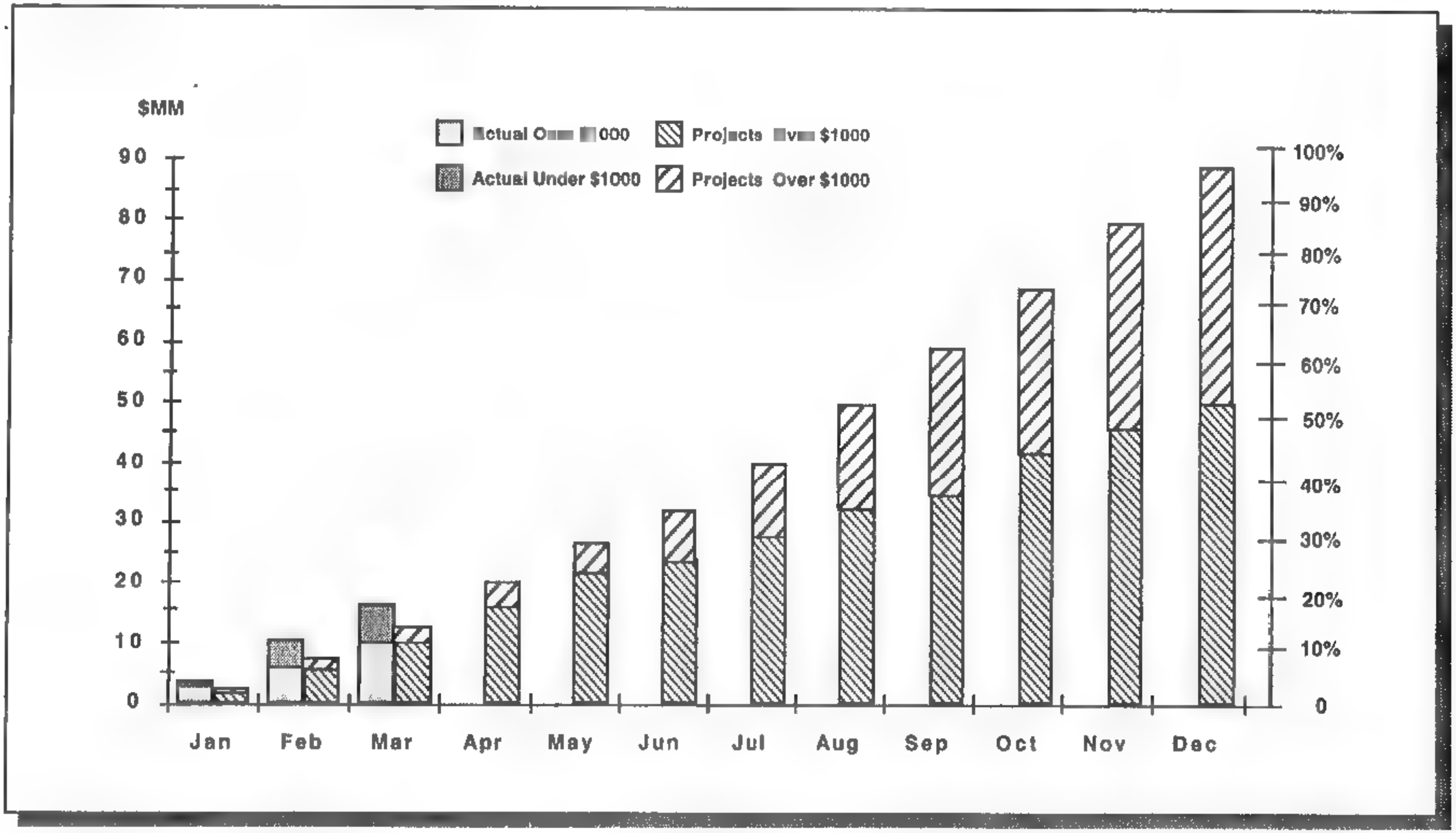
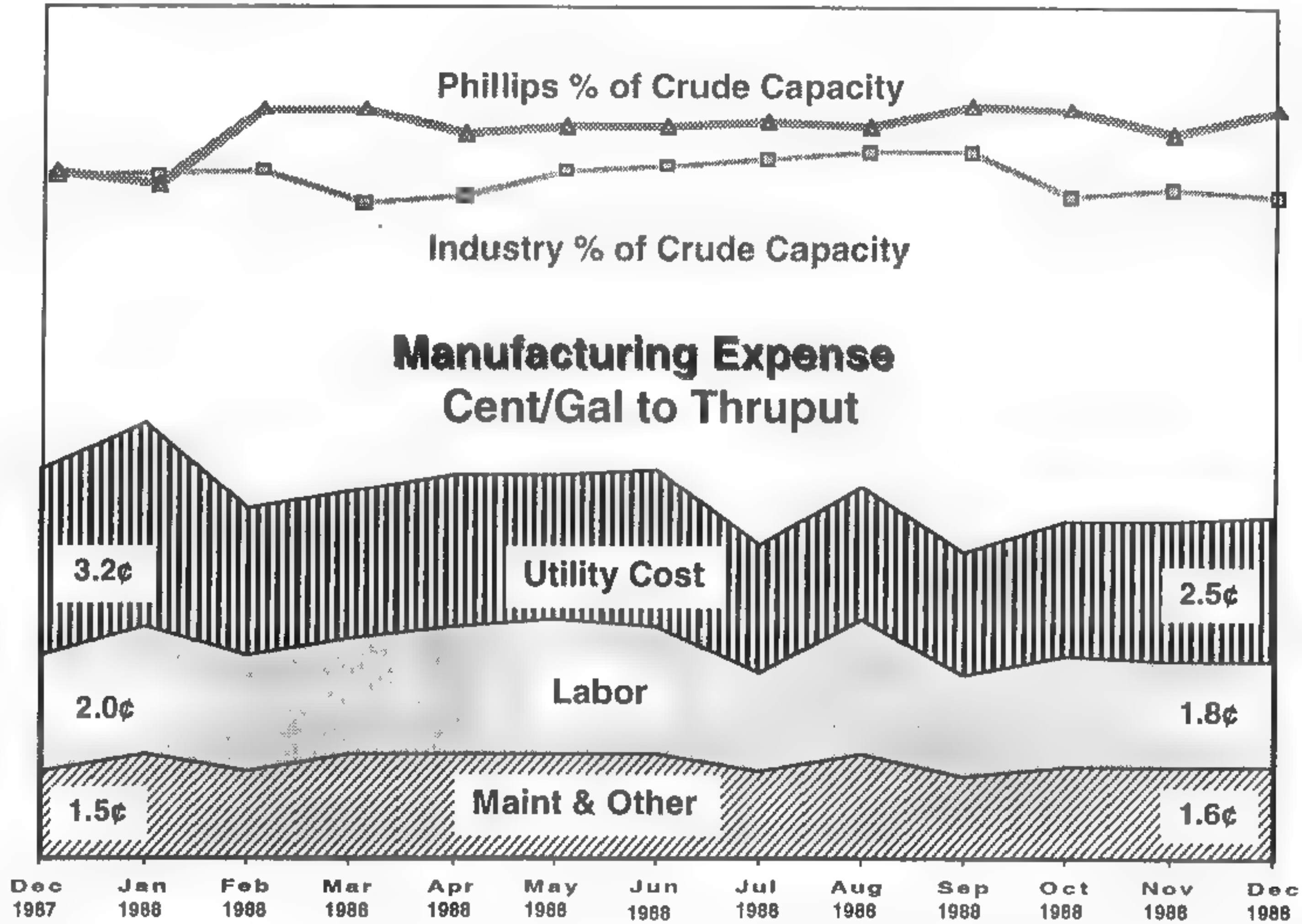
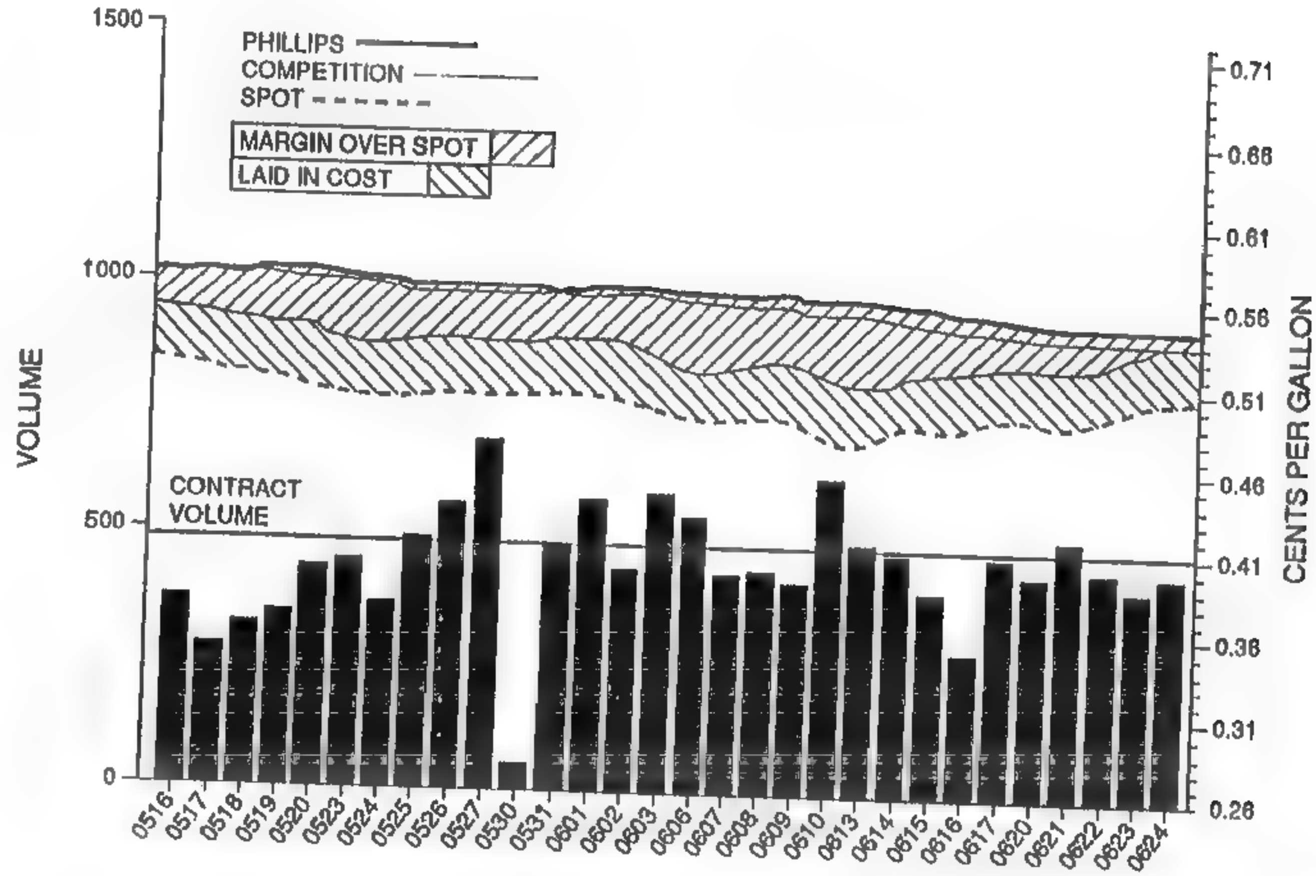


Exhibit A-3 Petroleum Products Operations*



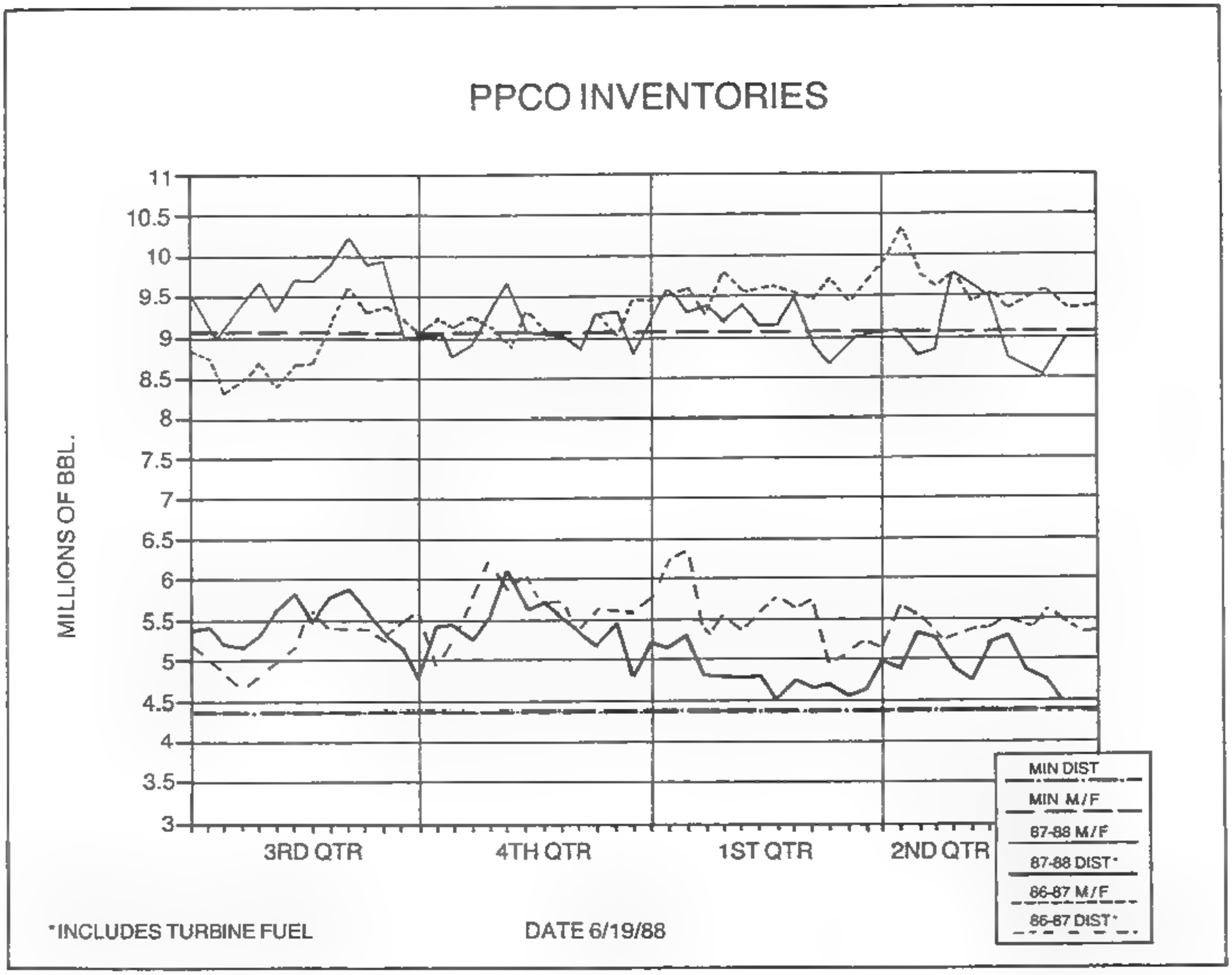
*Data were disguised.

Exhibit A-4 Phillips Pricing and Motor Fuel Sales



This is one of a number of screens that provided pricing and volume sales information to Phillips 66 managers. The chart provides comparative data on Phillips 66 price, competitor price and the price of motor fuel on the spot market for each local market area. Price data is also compared with the volume of motor fuel sold and the contract volume. The data are updated on a daily basis for all local market areas and are then aggregated at a regional and corporate level. This information display also shows monthly trends; other displays within the system show year-to-year trends. The chart format was created by pricing specialists and senior managers in Phillips 66 corporate headquarters. Information was obtained from internal corporate databases and an external information supplier that specialized in providing industry and economic data for the oil industry. The information relevant to their specific market area was provided to operating managers who assumed responsibility for pricing decisions in 1985. Regional managers received aggregate data concerning price and volume trends in their region and could "drill down" to view local information within their region if they wished to investigate areas of concern or opportunity in more detail. Pricing specialists at corporate headquarters and senior management received aggregate information on pricing and could also "drill down" to view regional or local information throughout the corporation.

Exhibit A-5 Phillips Petroleum Inventories



Source: Phillips 66 Company

Exhibit A-6 Sample Responsibility Statement*

December			Year-To-Date		
1987 Actual	1987 Target		1986 Actual	1987 Target	1987 Actual
		Motor Fuel Sales			
		Volume–MM Gal			
		Margin over Crude -¢/Gal			
		% Branded			
		Distillate Sales-Normal			
		Volume-MM Ga			
		Margin over Crude -¢/Gal			
		Avg. Gas Sales-Normal			
		Volume-MM Ga			
		Margin over Crude -¢/Gal			
		Turbine Fuel Sales-Normal			
		Volume-MM Gal			
		Margin over Crude -¢/Gal			
		Other Revenues			
		Lube contribution			
		SP. Prod. &TBA Contrib.			
		Marketing Division Expenses			
		Total Division Exp			
		¢/Gal Normal Sales Vol			
		Credit Card Office Exp			
		Dist/Reg/Div Overhead			
		Brand Advertising			
		Company Operated Stations			
		Refining Prod Volume-MM Gal.			
		Total Revenue			
		Contribution over Mkt. Territory Price			
		Contribution ROA			
		Number of Stations			
		Average Appearance/Serv.			
		Standards Score %			
		PH Aviation Svcs Contr.			
		Capital Expenditures			
		Accounts Receivable			

*Data are not included to protect company proprietary information.

Exhibit A-6 (continued) Sample Responsibility Statement: Consolidated Monthly Contribution Summary*

Dec.			Year-To-Date		
1987 Actual	1987 Target		1986 Actual	1987 Target	1987 Actual
		Petroleum Products			
		Plastics			
		Chemicals			
		Profit Ctr Contribution			
		Group Non-Allocated			
		Group Non-Operating			
		Group Contribution			
		Capital Employed			
		Contribution ROA %			
		Change in Working Capital			
		Capital Expenditures			
		HCC Rebuild Capital Expenses			
		Cash Contribution			
		MF Sales-MM Gals			
		Price -¢ Per Gal			
		Mar over Crude -¢ Per Gal			
		Dist Sales-MM Gals			
		Price -¢ Per Gal			
		Mar over Crude -¢ Per Gal			
		Crude Thruput-MB/D			
		Cost -$ Per BBL			
		Ethylene Sales--MM Lbs			
		Price -¢ Per Lb			
		Gross Margin -¢ Per Lb			
		Polyethylene Sales-MM Lbs			
		Price -¢ Per Lb			
		Feedstock Margin ¢/Lb			
		Petroleum Products			
		E/A Division			
		Total Contribution			
		Capital Employed			
		Contribution ROA %			
		Capital Expenditures			

*Data are not included to protect company proprietary information.

16

WHARTON REPROGRAPHICS

HARVARD BUSINESS SCHOOL

9-188-105
Rev. 2/19/91

THE BROOKLYN DA'S OFFICE: CLIENT CONTACT SYSTEMS

Research Associate Art Warbelow and Professor Benn Konsynski prepared this material as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

Elizabeth Holtzman, Kings County District Attorney, listened as Zachary Tumin, Special Assistant for Policy and Planning, described potential applications of leading-edge information technology in the Complaint Room, where initial contact was made with most cases handled by her office. By both temperament and political belief a reformer, Holtzman was ready and willing to explore information technology (IT) as one of the tools to drive change and upgrade the quality of justice in Brooklyn.

Tumin was proposing two related but fundamentally different sets of projects. The first was a two-way video link between the 23 local precincts and Central Booking. Assistant district attorneys (ADAs) could interview witnesses, police, and defendants without the need for time consuming and expensive travel by either party.

The second project was more esoteric, involving the use of emergent artificial intelligence technology to aid the ADAs in their decision-making processes. Several applications were possible, supporting different parts of the process--from initial interviews to case evaluation to a standardization of the plea bargaining.

Holtzman wanted to focus her resources where she would find the most leverage; some applications would yield more benefits with a given effort. She was concerned about the second-order impacts of these projects and how they would change the organization and the case handling process.

Change was needed. The current system discouraged client participation, losing valuable victim and witness information. Downstream case processing was being adversely affected. At the same time, costs were skyrocketing as police overtime mounted and the case load increased. Innovative applications of IT were, she believed, appropriate for the environment, would advance the cause of good government for which she stood, and would bring recognition to her office.

The Brooklyn DA's Office

The Brooklyn DA's office was one of the largest in the country, with a $28.0 million budget for FY 1987 and more than 800 employees, half of whom were attorneys (see Exhibit 1). It was responsible for handling more than 70,000 cases annually, virtually all of which were provided by the New York City Police Department (NYPD).

The DA's office was wedged between the police department on the one side, which generated the cases for prosecution, and the courts on the other side which decided the cases. Well-defined legal principles governed its operations, although considerable discretion was available to focus the resources in particular areas and ways as the DA saw fit.

Elizabeth Holtzman was elected Kings County DA after serving four terms as a U.S. congresswoman, in which she distinguished herself as an independent, intelligent and hardworking representative with a liberal voting record. She gained national prominence during the Nixon impeachment hearings for her tough and relentless line of questioning. In 1980 she was narrowly defeated in a bid for the US Senate. In taking on the DA's position in January, 1982, Holtzman's strategy for the DA's office included five underlying concepts:

- tough prosecution of violent crimes and dangerous offenders
- pro-active investigation attacking criminal conspiracies
- achieving high degrees of professionalism and integrity
- representing and serving victims of crime
- promoting responsiveness and accountability to the citizens of Brooklyn, and becoming a leader of crime control efforts in the community.

Physical Facilities and Staffing

The DA's office was physically located in four buildings. Its Complaint Room was housed in the NYPD's 84th Precinct Building, a three story brick structure situated at the corner of Gold and Tillary Streets. In an inconvenient and depressed section of downtown Brooklyn, a fifteen minute walk from the nearest subway stop, the building also housed the NYPD's Central Booking facility.

As the "front end processor" for the DA's office, the Complaint Room was where nearly all cases were first processed. It operated 24 hours a day, 7 days a week, with a staff of 10 to 20 paralegals and ADA's.

The office's other attorneys and support personnel were located in three other facilities about 10 blocks away. All specialized Bureau Chiefs, as well as Holtzman's office were located there.

An entry level ADA's salary was about one-half that paid by New York's major private law firms. Rapid expansion of the office in the early 1980's, increasingly heavy workloads, and attractive private sector salaries had accelerated attrition and turnover in recent years. Many ADAs came to Brooklyn to gain trial experience and most became private defense attorneys after serving out the three-year commitment they made when hired. Where five years earlier ADAs in the Complaint Room might have had 20 or 30 trials

to their credit, the senior ones might now have 4 or 5. Those with more experience were reserved for trial preparation.

To alleviate the problem and maintain some control over the process, Holtzman had reduced much of the Complaint Room's ADA's latitude and discretion in charging cases over the past five years. Major decisions once made by the more experienced ADAs in the Complaint Room were now reserved for the specialized bureaus.

The Case Management Process

Managing a case involved a complicated procedure that varied with the nature and seriousness of the offense. For a limited class of the most serious cases, a "riding DA" notified by the police shortly after the arrest would go directly to the scene of the crime to aid in the investigation, or the police station to help interrogate the witness. This action was particularly important where the suspect indicated a willingness to make a statement or confess to a serious crime. The interrogation would be videotaped to preserve the confession, as well as prove to the court that coercion had not been used. "Riding DA's," as well as videotaped confessions, were innovations not used elsewhere when introduced in Brooklyn in the early 1980s.

But for most cases, the first knowledge the DA's office had came only after the police officer completed the defendant's processing at one of Brooklyn's 23 precincts and transported him downtown to the NYPD's Central Booking facility at the 84th Precinct Facility. There, police input operators keyed in the officer's hand written arrest report forms, opening a file for the case in the department's On Line Booking System (OLBS) and generating an arrest number for case tracking purposes. The defendant's fingerprints were taken and faxed to Albany for identification and criminal records search.

Once the Central Booking computers printed out a hard copy version of the officer's arrest report, he logged out of Central Booking with his documents and crossed over to the other side of the building to the District Attorney's Complaint Room. This typically occurred within five to seven hours of the arrest.

At that time the defendant was offered the opportunity to record or videotape a statement. Afterwards, or if he chose not to do so, the defendant was moved out of Central Booking to the holding pens in the basement of Brooklyn Criminal Court to await arraignment, or to a precinct holding tank elsewhere in Brooklyn or Manhattan if the courts were too crowded or closing.

It was common practice for an arresting officer to suggest to the victim once they had finished the processing at the local precinct that the victim meet the officer downtown at the Complaint Room for interviews with ADAs. The prosecutors needed the interview to gather all the facts and to charge the defendant accurately. But Police Department policy forbids the officer from transporting the victim and the defendant together in the same car, and typically the precinct was loathe to commit an additional vehicle for this purpose. As a result, in the hours following a crime, victims and other witnesses who wished to contribute further to the case were responsible for their own transportation downtown to the Complaint Room, at their own expense, to "tell their story" yet again, this time to an ADA.

In fact, the arduous travel requirements for the interviewing process limited participation. After having been victimized, the witness was faced with the difficulties of traveling to the Complaint Room regardless of weather or time of day, with no transportation provided no matter that it might mean a day's loss of work and pay, or school. Of civilian witnesses, 80-90% declined making the trip. Effective screening of the

cases was then pushed back to the grand jury 2-3 days later, where the ADA might meet witnesses for the first time in the bulk of cases.

If a victim chose to make the trip downtown after the crime but arrived before the arresting officer, he or she waited in the adjacent Victims Assistance Room. Once the officer cleared Central Booking and joined the victim in the waiting room, they entered the line for interviews with Complaint Room ADAs. Officers with victims were jumped to the head of the queue.

Although actual service time took only one hour, the wait for service took another six to seven hours, on average. On busy nights, officers without witnesses could wait 15 hours or more for their cases to be called. Forty or fifty officers might fill the stairwells and hallways, looking for a place to sit or lean, to rest or sleep while they waited for the next available ADA. The average total elapsed tme in service for officers following arrest was about 14 hours. Overtime accrued for all hours worked in excess of the normal 8 hour tour of duty, at the rate of $24 per hour.

Inside the Complaint Room, attorneys, officers, witnesses, paralegals, clerks and input operators rubbed shoulders in a cramped, bustling hub. Desks separated by low partitions lined both sides of the long narrow room. Data entry was grouped in one area, with the interviewing for felonies and misdemeanors in other areas. Modern upholstered furniture and carpeting had once been installed to improve its character. But it soon wore out from the accumulated filth of constant use day and night, the endless grinding of cigarette butts and occasional insect infestations, and was replaced by linoleum floors and more durable institutional plastic and metal desks and chairs.

Complaint Room ADAs screened the case by examining the facts, and applying the law and office policy. The most experienced lawyers decided what charges to draw up and how the case was to be "tracked." The charges were drawn up in an affidavit called the complaint, on which the defendant would soon be arraigned. Once the ADA's computers typed the complaint, it was sworn to and signed by the officer or victim. Felony cases were then assigned to one of several tracks, which determined the path of further processing.

The most serious cases were classified as "A" cases. They were arraigned in criminal court and presented to the grand jury for indictment within 24 hours. The next most serious cases were classified "B" (regular), "C up," or "C." "B" meant no plea would be taken at arraignment. The designation "C up" meant that the case could increase in importance pending the receipt of additional witness or offender information. Cases designated "C" could be resolved quickly if the defendant agreed to plead guilty to a misdemeanor, perhaps even at arraignment. The least serious felony cases were designated "C down" or "D." and usually were disposed of through pleas to misdemeanors.

Case files containing the complaint, the arrest report, and the defendant's criminal history went from the Complaint Room (in operation 24 hours a day) to criminal court (open 16 hours a day) for arraignment. If the criminal courts were closed, the defendant was taken back to the precinct house until the next day to await arraignment, whose purpose it was to satisfy the judge that there was "probable cause" for holding a defendant and to set bail.

After arraignment, the case was prepared for indictment. If the suspect was incarcerated, the case would come before the Grand Jury within the week. If not, two weeks or more might pass. An initial plea offer was made before the indictment. After indictment, a case could wait an average 11 months for trial. Most of the resources of the DA's office were focused here, on trial preparation. Unlike "riding DA" duty, which was performed by relatively inexperienced ADAs, felony trial preparation was reserved for the

more experienced attorneys. Because of frequent turnover and rapid expansion of the office, cases were sometimes prepared just before the scheduled trial date.

Cases were assigned to one of several prosecuting bureaus, depending on the nature of the case. Most misdemeanor cases were assigned to the Criminal Court Bureau. Most felony cases were assigned to the Supreme Court Bureau or one of several specialized bureaus. Cases involving sex crimes, narcotics, organized crime, or economic crimes were assigned to specialized bureaus whether misdemeanor or felony.

A large percentage of the cases were settled through negotiated pleas, with about 10% of the felony cases eventually going to trial. Roughly 4 months to a year elapsed between arrest and conviction, longer for jury trials. Some defendants viewed the delays as an illicit method of punishment, without benefit of a trial. Others welcomed delays, hoping that a case might deteriorate over time, as witnesses lost interest, confessions were recanted, police memories faded, or physical evidence was misplaced.

The Changing Environment

Holtzman knew that victims of crime in New York were often repeatedly victimized--the poor, the weak, and the elderly were easy targets. Many did not own automobiles or telephones, and poor access to public transportation made the trip to the Complaint Room a formidable obstacle. As a result, valuable witness and victim information was lost or delayed.

She felt that there had to be a way to get witnesses more involved, and give ADAs the information necessary to strengthen cases, and prosecute them as vigorously as possible. For serious crimes, the "riding DA" program was worthwhile, but it was not the solution to all cases. Holtzman simply did not have enough ADAs to conduct all the interviews that were needed in the field.

Holtzman challenged her staff to devise solutions. Arrest volume was soaring: from 48,000 cases in 1982, to more than 70,000 cases in 1986, and the arrest processing costs were increasing at an equally rapid rate.

The Video Project

Zach Tumin's first proposal was to install a full-motion two-way video-telephone link between each of the 23 precinct houses and the prosecutors at their central Brooklyn location. "Electronic" interviews would be substituted for the in-person interviews obviating the need for the arresting officer and witnesses to travel downtown. The complaint would be telefaxed to the precinct for signing, and then later transported downtown with the defendant for arraignment.

Interviews conducted over the video link would not be taped. The record of the interview would be contained in the ADA's written notes, just as in a face-to-face interview.

The link could be established using twinned 56 kbs telephone lines to provide 112 kbs bandwidth per video-telephone link. Because of the limited bandwidth, substantial computing power was necessary at each end to compress the audio and video signals, which resulted in a slight delay, much like talking over early satellite links. The technology was leading edge, but still rapidly developing. The quality of the available picture was less than perfect--details of facial expressions might be indistinct, and "looking into a person's eyes" was difficult. But Tumin thought it would be superior to telephone-only interviews, and much better than none at all.

Terminals would be installed at each precinct to match historical case loads, with the busiest precinct getting three terminals, ten precincts getting two terminals, and the rest being served by one. Capacity for as many as 21 simultaneous interviews would be installed at the Complaint Room, to minimize police waiting time at the precincts. An alternative proposal would install video links only at selected precinct houses, with these serving as a "hub" to which neighboring precincts would come for video interviews.

Tumin believed that the video link would dramatically increase witness and victim participation, while having an equally dramatic impact on police overtime. For the first five months of 1987, four out of five arrests made in Brooklyn required overtime, and averaged nearly 8 hours apiece. He expected that the video project could reduce the number of cases requiring overtime, as well as the amount of overtime required per case. Witnesses would provide more information to prosecutors, with less burden and trauma to themselves.

Other benefits might be realized through expanding the system in the future. A video link to the courts would allow defendants to be arraigned while in the precinct houses, reducing the time between arrest and arraignment from days to hours. Inter-precinct links could be used by detectives to exchange information on cases or to interview witnesses in other precincts. If the law were changed to permit it, police officers could testify before grand juries without leaving their precinct, thereby avoiding travel and waiting time downtown. Finally, as cases were prepared for trial, prosecutors could discuss details and refresh their memories through video conferences with detectives and officers in their precincts, again avoiding travel and waiting time.

The expected costs of a complete video system connecting all precinct houses to central booking include (possible staff reductions at Central Booking or reduced police overtime charges have not been considered here):

Purchase video, telephone, computers, FAX, and related equipment:	$4,207,500
Facilities construction:	$ 225,000
Telephone line installation charges:	$ 64,000
Annual telephone line fees and equipment maintenance:	$ 448,000
Additional personnel salaries:	$2,850,870

Rather than move ahead with a full implementation of the system, Tumin proposed that a test be conducted by installing a link between the 73rd Precinct House and the existing Complaint Room. The 73rd was a distant precinct with a typical cross section of cases and complete statistics available on its past operations. Two video telephones would be installed in a room temporarily partitioned off near the Complaint Room's felony interviewing area. All 73rd Precinct case witnesses would be processed using the video system for several months. The functions of Central Booking would also be provided at the 73rd Precinct House, to simulate a decentralized booking process, and so that the arresting officer could complete all his processing without leaving the precinct. In addition, a shorter test would be conducted to test the alternative "hub" model, by bringing in witnesses from cases in adjacent precincts.

The CACE Expert Systems Project

If the video project succeeded in increasing participation rates of victims and witnesses from the then current 10% of cases to near 100% as expected, the central prosecutors office

would be hard pressed to provide the necessary interviewing resources. Little would be gained if limited interviewing resources created a bottleneck in the video system. Holtzman was also concerned with maintaining high standards for case evaluation; the more experienced attorneys were in relatively scarce supply, because trial preparation consumed most of their time.

A team of consultant system developers was called in to help develop a prototype "expert" computer system that could in turn help less experienced case evaluators interview, charge, and internally track arrest cases by providing advice, reminders and guidelines. A subordinate goal of the proposed system was to accelerate the process, in part by reducing redundant data entry. Systems would be integrated, and forms printed automatically based on data entered into the system at various stages of the arrest process.

DA staff and the consultants met in March of 1987 to consider how to proceed in developing the prototype. A subset of narcotics arrests involving buy-and-bust "peephole" scenarios was chosen as the initial area of applications. Narcotics cases represented nearly one-third of the Brooklyn case load, and developers felt that it was a fairly constrained domain. Unlike robbery or burglary cases, they involved only police and no civilians as witnesses, . Typically it was either a narcotics case, or it was nothing, unlike a robbery which might actually be a larceny or an assault, depending on the facts.

Initial prototypes of a menu-oriented interface for rapid gathering and entry of case facts were developed over the next two months, using Turbo Pascal. They were designed to gather data necessary to all cases. This front end would eventually be coupled to an expert system developed in Ml[1], which would ask the detailed case-sensitive questions and provide case analysis and intelligent charging recommendations. It would rely heavily on knowledge engineering and rule-based representations.

An incremental approach was taken to the project, starting with rules of rather large granularity, to demonstrate the system to experts in the Brooklyn office, and then modifying the rules to capture more detail. Harvey Casper, of the Brooklyn Narcotics Bureau, had provided the initial expertise for the coarse grained model of the fact patterns needed for the various relevant narcotics charges (sale, possession, and possession with intent to sell). A finer-grained model was then developed on the Ml software, which broke down the concepts used in the first model. See <u>Exhibit 3</u> for representative examples of the 249 rules used in this prototype. Questions were displayed on the computer screen, along with a list of answers from which the user could select. Typically after asking a dozen or more questions, the program would present the recommended charges. See Exhibit 2 for an example of the question-and-answer interface as well as a recommended charge. The line of reasoning used by the computer could be traced by the user if desired, although an understanding of the program helped in deciphering the output. See Exhibit 4 for a trace of the first two questions asked by the program; the full trace of a session might extend for 10 pages or more. Initial feedback on the system was positive, and Tumin planned to conduct a hands-on test with the ADAs soon.

The system, called Computer Aided Case Evaluation (CACE), would ultimately be integrated with other sources of electronic information, including police on-line booking systems and defendant criminal history data from state identification systems. Once the evaluator accepted the recommendation provided by CACE, it would be programmed to select, fill out, and print all appropriate forms, including the complaint. Finally, the

---

[1] Ml is an expert system "shell" developed by Teknowledge, Inc., which runs on an IBM or compatible personal computer.

accumulated data would be dumped into an office case-tracking system to open a new electronic file for each case.

Clear-cut cases would be completed by paralegals aided by CACE, and those that were troublesome, borderline or otherwise "difficult to call," CACE would flag, and an experienced attorney in a supervisory position would be called in to make the decision.

Once CACE demonstrated satisfactory performance on narcotics cases, Tumin planned to expand its scope to include robbery and burglary cases, most of which involved civilian witnesses, making the charging decision more ambiguous.

Extensions of CACE: The PLEABARX System

The PLEABARX system Tumin proposed was designed to implement standardized, one-time-only plea bargain offers, a policy Holtzman expected would provide consistency between cases and substantially increase the price of committing a crime in Brooklyn. It was seen as an extension of standardized charging provided by the CACE system.

PLEABARX was envisioned as a computer-based system using artificial intelligence techniques to structure the process of plea bargaining. The computer program would use data retrieved from surveys of hundreds of closed felony cases in Kings County to identify the probable outcomes of plea negotiations, trial and penalty for different offers on cases. Using these plea outcomes and trial forecasts, office policy could be planned regarding the minimum acceptable plea offer for any given combination of case and defendant elements.

The policy would then be embodied in a computer program into which "live" case data would be entered as cases were indicted. For any combination of case and defendant characteristics, such as criminal histories, the computer program would specify the minimum and maximum plea offer to be made in each case. The system would then be used to implement an experimental policy of one-time-only plea bargains.

Implications and Limitations

As Holtzman reviewed the potential applications of information technology available to support her strategic goals, she pondered the unexpected second-order impacts they might have and the limits of the technology. She wanted to ensure that people did not rely too much on the computers and neglect to think.

Embedding intelligence in the early case processing would change the roles of the people involved. How would they accept the new technology? Would the police and witnesses object to being interviewed over a video link and by a computer aided interviewer? Most of the ADAs considered a tour of duty at the Complaint Room as a necessary evil before getting to the real work of trial preparation. Possibly ADAs could be replaced completely in this function by paralegals. Maybe the system could even be decentralized to the police in the local precincts. But would the interests and values of the DA's office be represented?

Finally, how far along the processing stream could technology be applied? Should she experiment with a computer-aided plea bargaining process? Were there other potential applications?

Exhibit 1
THE BROOKLYN DA'S OFFICE: CLIENT CONTACT SYSTEMS
Organization Chart

Office of the Kings Country District Attorney

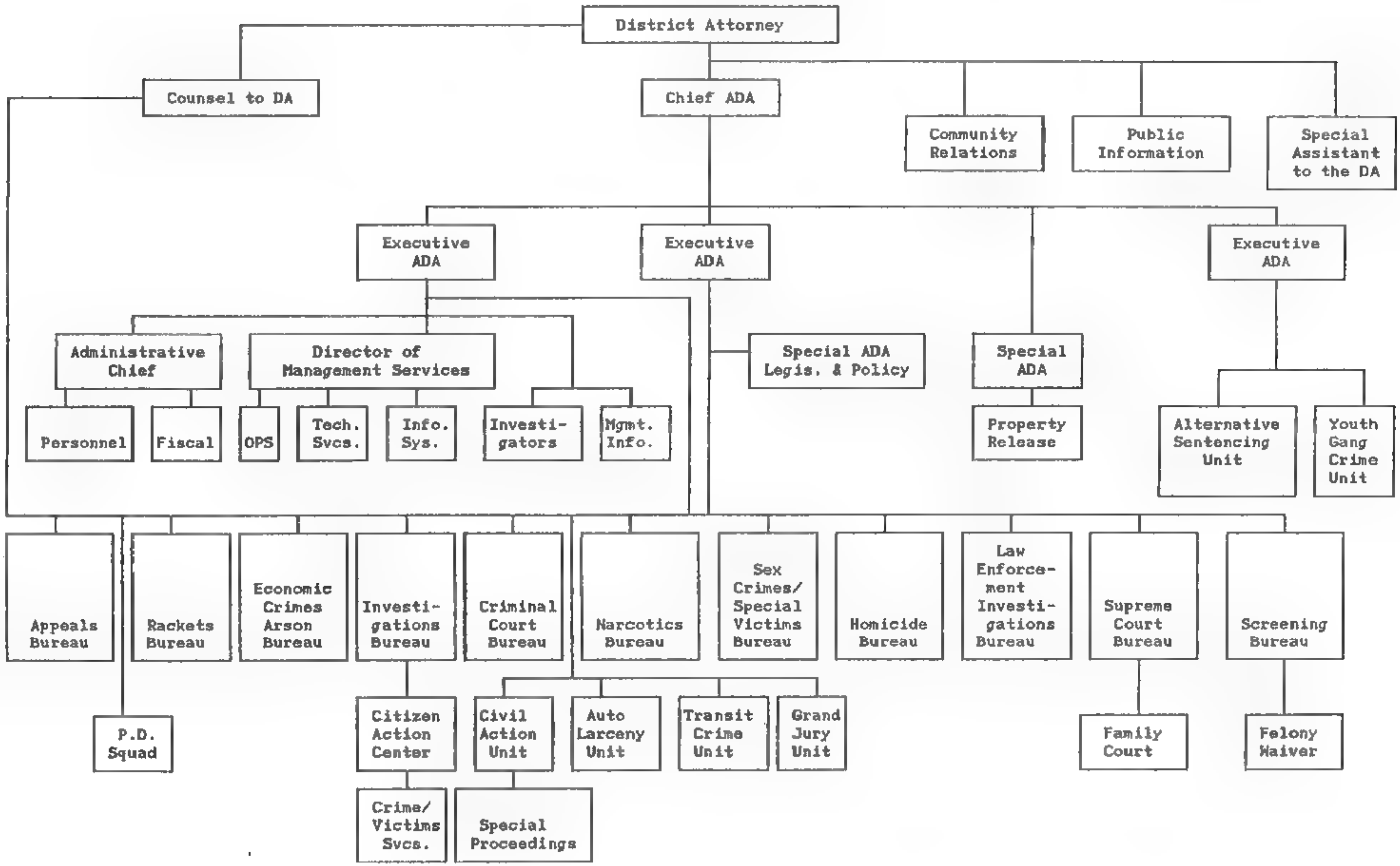


Exhibit 2

THE BROOKLYN DA'S OFFICE: CLIENT CONTACT SYSTEMS

CACE Input Screen

Execution Knowledge Base Cache Tracing

APPLICATION DISPLAY

Charge 1 count of 220.39 for sale of narcotics
Charge 1 count of 220.16 for possession with intent to sell narcotics
Charge 1 count of 220.03 for possession of narcotics

QUESTION

Did the crime take place on or near school grounds?

ANSWER

yes
no
unknown

CF

Space to Mark

F2 Scroll F9 Mode F10 Menus M.1 Teknowledge, Inc. READY

Exhibit 3

THE BROOKLYN DA'S OFFICE: CLIENT CONTACT SYSTEMS

CACE Example Rules

```
kb-20:
    if X-drugs = heroin or
       X-drugs = cocaine or
       X-drugs = pills
    then X-charge_drugs = narcotics.

kb-31:
    if sale-drugs = D or
       found-drugs = D
    then possession-drugs = D.

kb-36:
    if type of sale = undercover or
       (buyerArrested = yes and
        askUser('Can the police describe what was sold?') = yes)     then
saleRecovered = yes.

kb-48:
    if (sale-track = c_down or
        possession-track = c_down) and
       (not record = maybe or
        (record = maybe and
         display(['NOTE:',nl,'If defendant has any pending felony charges',
        ' or prior felony convictions,',nl,
         '    or is currently serving any sentence or has ',          'a
serious record,',nl,'the case must be retracked',          ' to B - no
arraignment disposition is permitted.',nl,nl])))     then track = c_down.

kb-66:
    if D-possessed = Q and
       possession-degree(D,Q) = second
    then possession-charge(D) = 220.18.

kb-98:
    if type of sale = undercover and
       pills-found = 0 and
       cash-onPerson = C and
       C<= X
    then reduce(sale,pills) = yes.

kb-112:
    if near_school = yes or
       record = yes
    then noReduce = yes.
```

Exhibit 4

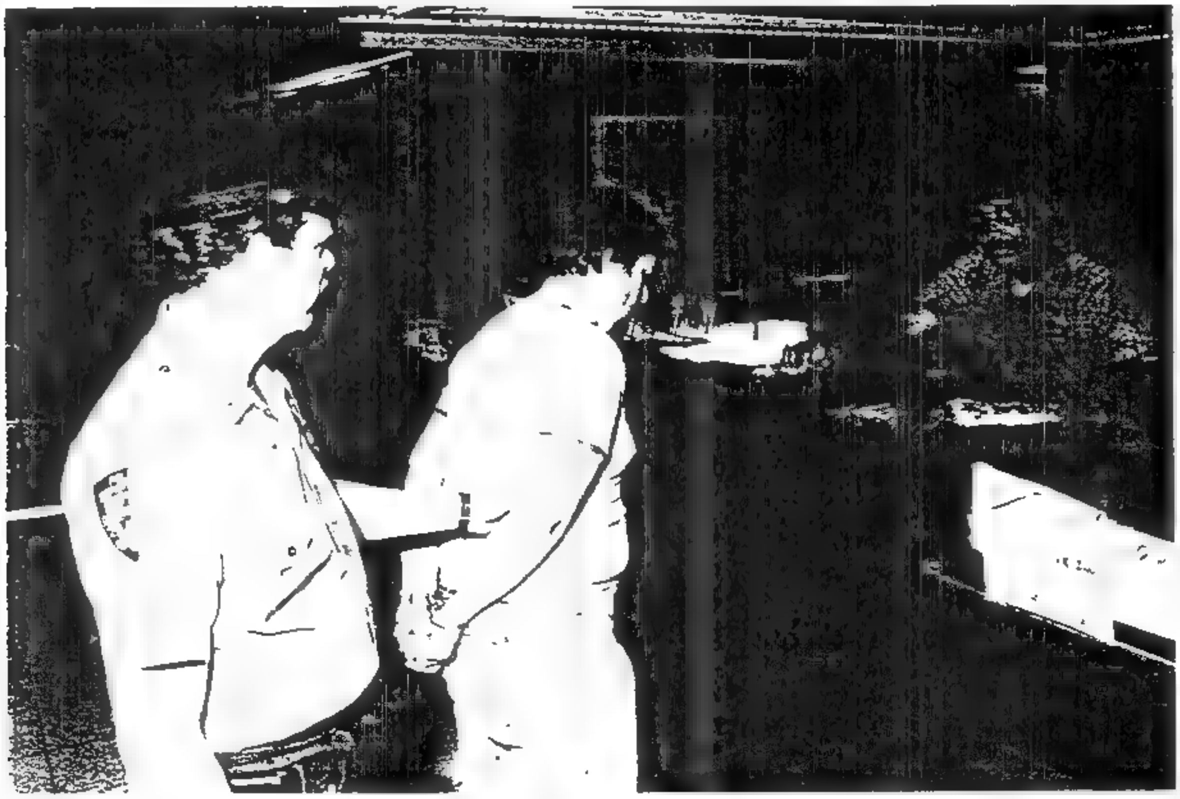
THE BROOKLYN DA'S OFFICE: CLIENT CONTACT SYSTEMS

Trace of the CACE Reasoning Process

```
go
Seeking display-charges.
Using kb-1:
    noautomaticquestion(display-charges).
Invoking kb-7:
    if charges is known and
       charges = [sale,C,D] and
       display(['Charge 1 count of ',C,' for sale of ',D,nl]) then display-
charges = [sale,D].
Seeking charges.
Using kb-1:
    noautomaticquestion(charges).
Invoking kb-11:
    if arrestCharges = sale and
       sale-charge_drugs = D and
       sale-charge(D) = C
    then charges = [sale,C,D].
Seeking arrestCharges.
Using kb-1:
    noautomaticquestion(arrestCharges).
Invoking kb-16:
    if askUser('Did the defendant sell any drugs?') = yes then
arrestCharges = sale.
Seeking askUser(Did the defendant sell any drugs?).
Using kb-1:
    noautomaticquestion(askUser('Did the defendant sell any drugs?')).
Using kb-2:
    question(askUser('Did the defendant sell any drugs?')) = ['Did the
defendant sell any drugs?'].
Did the defendant sell any drugs?
yes cf 100
Noting askUser('Did the defendant sell any drugs?') = yes cf 100 because
you said so. Found askUser(Did the cefendant sell any drugs?).
Noting arrestCharges = sale cf 100 because kb-16.
kb-16 succeeded.
Invoking kb-17:
    if saleRecovered = yes or
       askUser('Were any drugs found on the defendant?') = yes then
arrestCharges = possession.
Seeking saleRecovered.
Using kb-1:
    noautomaticquestion(saleRecovered).
```

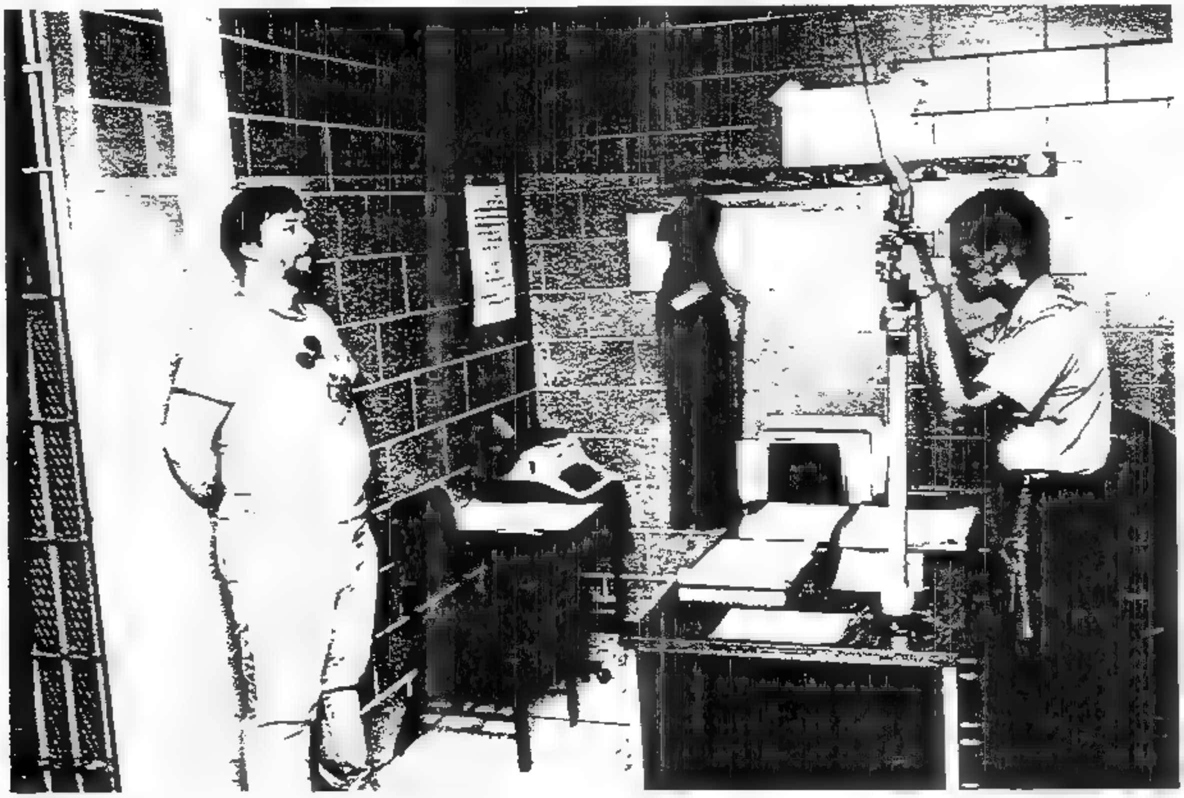
Storyboard of the Post-Arrest Process

1 - Initial booking and searching occurred before the precinct desk officer.

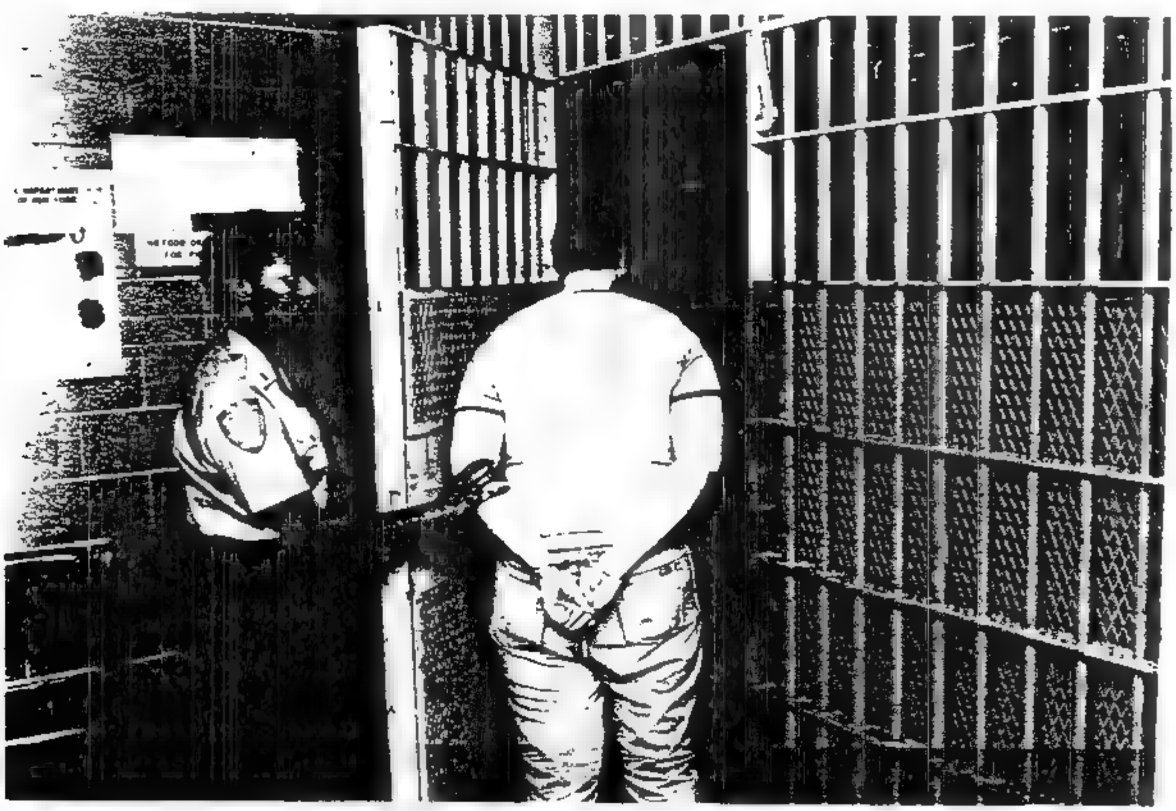


2 - While the arresting officer prepared the first eleven lines of the On-Line Booking system (OLBS) worksheet, the precinct arrest processing officer fingerprinted the prisoner in the first floor detention area opposite the desk.

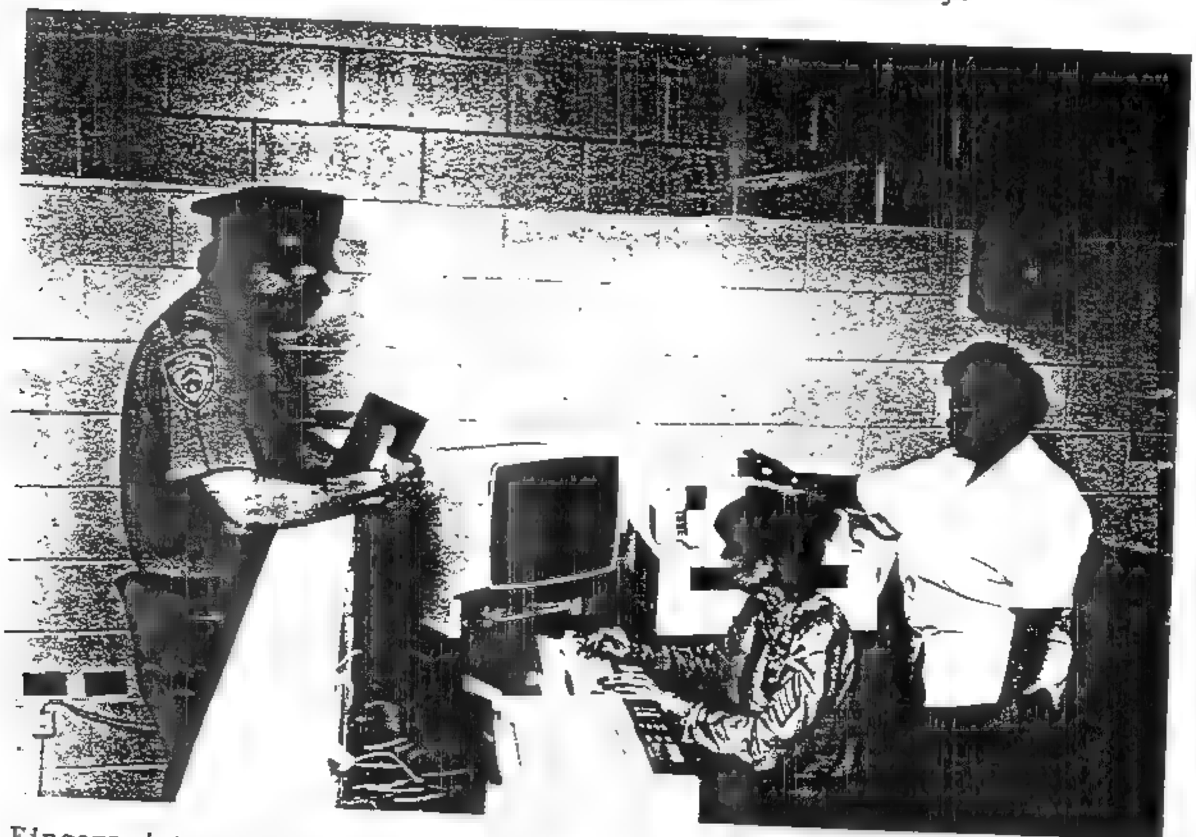
3 - The prisoner was then photographed and offered an opportunity to make telephone calls.



4 - The prisoner was then placed in temporary detention while the booking process continued.



5 - The officer then reported to the second floor booking facility where the first eleven lines of the OLBS worksheet were input. This represented the minimum amount of information required for entry into the OLBS and transmission of fingerprints to Albany.

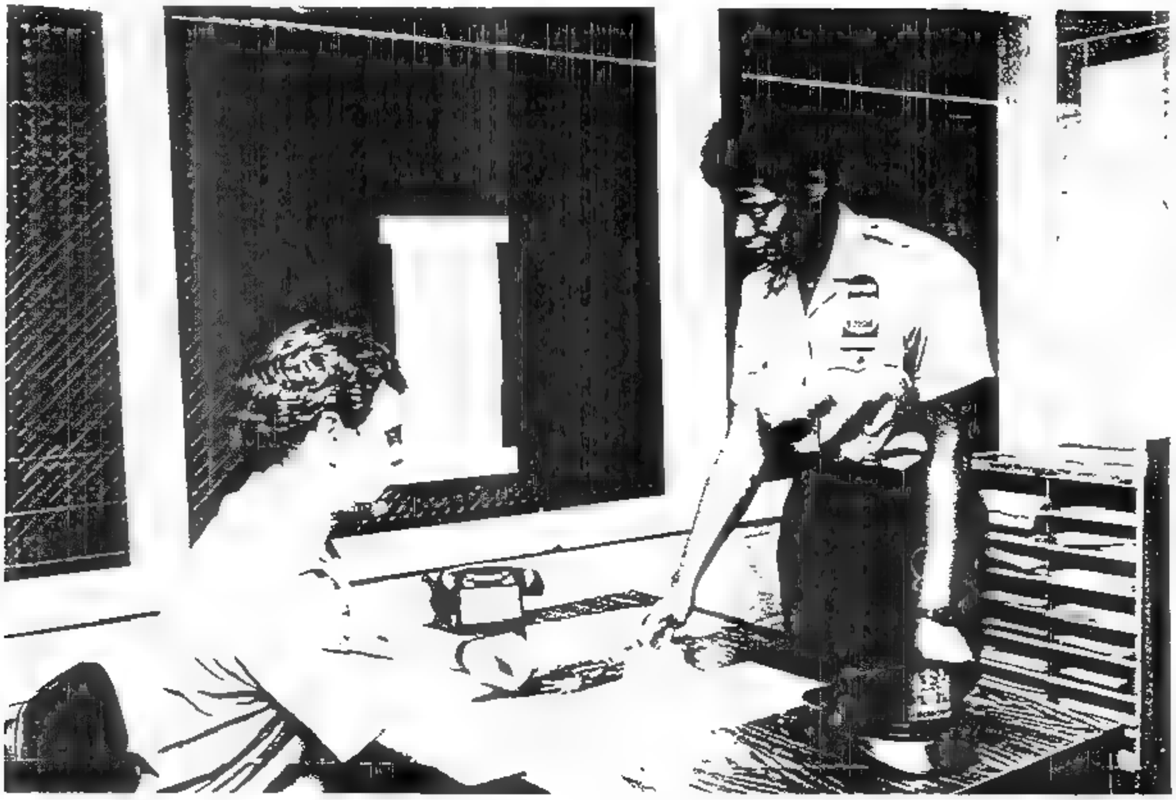


6 - Fingerprints were then transmitted to Albany via the Data Log machine. Once these were received, Albany could then begin preparing the "rap" sheet which could take several hours. It was sent to Central Booking, where it would eventually unite with the complaint and prisoner for submission to the court at arraignment.

7 - In the event reprinting was required, the booking facility was notified, and

8 - The prisoner, still in detention on the first floor, was reprinted.

9 - The complaint report was then prepared.



10 - Required notifications were made.

11 - Property was invoiced for safekeeping or presentation to the court.

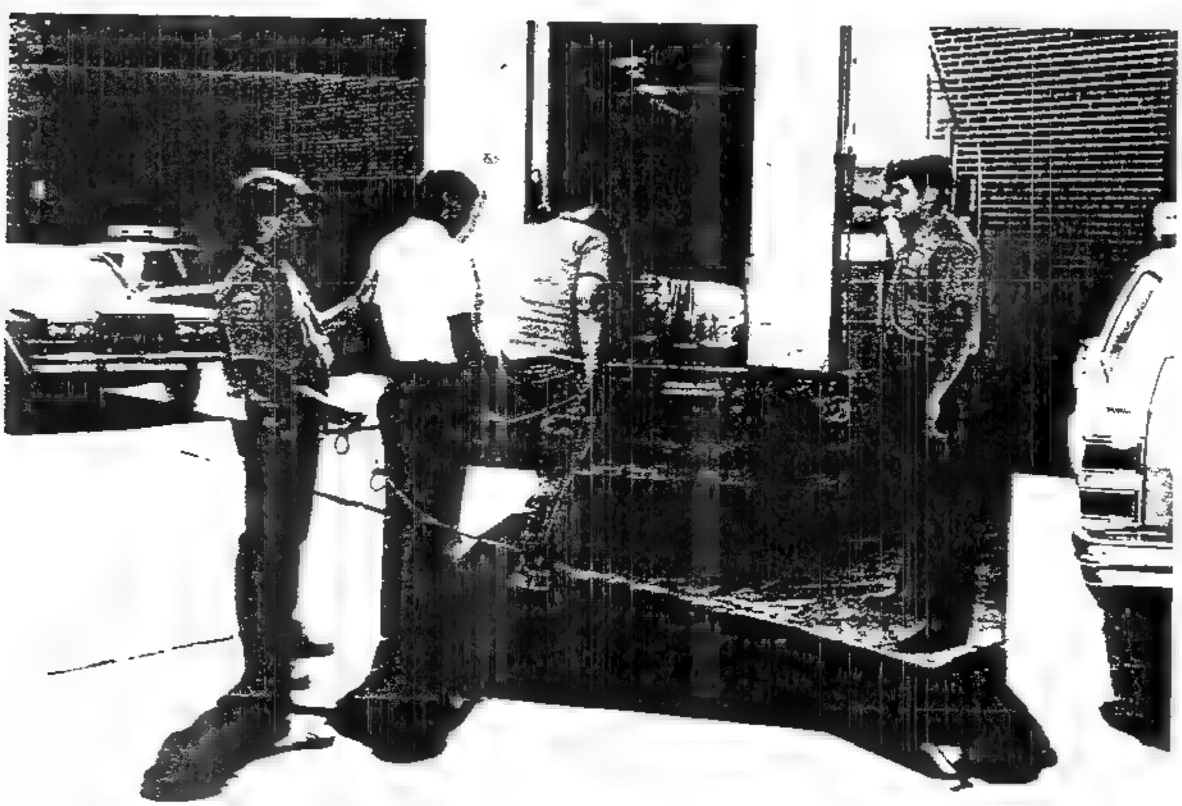
12 - The officer then returned to the second floor where the additional information was added to the OLBS. Copies of the OLBS worksheet, UF, 61, and any other related documents were presented to the booking clerk who sent it by FAX to the Brooklyn DA's Complaint Room. This transmission served as a signal that an ADA was required for a video-phone interview.

13 & 14 - The responding ADA interviewed the officer, complainant and any witnesses involved.

15 - Upon completion of all interviews, the assigned ADA processed the case, prepared a court complaint, and sent it, via FAX, to the precinct where it was signed and sworn to by those interviewed. At this point, the arresting officer's tour was completed and all complainants and witnesses were excused.

16 - Twice a tour, or more frequently when activity dictated, a court division patrolwagon operator collected the signed complaints and related papers from the booking sergeant.

17 & 18 - Prisoners awaiting arraignment were then transported to Brooklyn Central Booking where they underwent probation interviews. The arrestees, along with their completed fingerprint rap sheets from Albany, and their signed court complaints, were then presented to court for arraignment.



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OPIM 210 - Midterm Examination

Spring, 1998

Professor Hitt

March, 1998

For this exam you are allowed one sheet of paper (8 1/2" x 11", both sides) for notes, but no other materials may be used. You will have 80 minutes to complete this exam.

Name or SSN (for anonymity in grading):

___

Part I - Multiple Choice (36 points total/2 points per question)

Please choose the best answer to the following question (circle the letter corresponding to your choice).

1. Which of these provides the fastest data communication speed:
a. ISDN
b. T1
c. 10-base-T
d. 100-base-TX
e. T3

2. Triangles and squares are all closed polygons. All closed polygons have an area. A data structure that "knows" that triangles and squares have an area, only using the two previous assertions is utilizing:
a. encapsulation
b. inheritance
c. polymorphism
d. abstraction
e. selection

3. An electronic meeting room or GDSS (as described in class) is an example of:
a. A same-time, different-place groupware tool
b. A same-time, same-place groupware tool
c. A different-time, same-place groupware tool
d. A different-time, different-place groupware tool
e. None of the above

4. The assembly language for a Pentium processor is an example of a:
a. First generation language
b. Second generation language
c. Third generation language
d. Fourth Generation Language
e. Fifth Generation Language

5. TCP/IP and UDP are both examples of:
a. Network protocols used on the internet
b. Network protocols used only on local area networks
c. Protocols used for analog communication
d. OSI Layer 2 services
e. OSI Layer 1 services

6. "Merced" is a 64-bit processor under development by Intel and HP for the use in workstations. From this description you know that:
a. It is faster than a Pentium
b. The data bus is likely to be 8 bytes wide
c. It is capable of executing SIMD instructions
d. It is entirely a RISC processor
e. None of the above

7. Some day soon, network cards will be able to communicate at speeds approaching 1Gigabit/second. To obtain maximum performance you would most likely connect this card to:
a. The serial bus
b. The ISA bus
c. The PCI bus
d. The memory bus
e. either the PCI or ISA bus

8. I am writing a program in which it would be useful to be able to automatically use features of Microsoft Excel (installed on the same machine). This could be best accomplished using:
a. the Excel API
b. DDE
c. ActiveX
d. JavaScript
e. None of the above can accomplish the task

9. The reason Phillips Petroleum could not achieve sustainable competitive advantage with the EIS is that:
a. It did not matter in a positive way
b. It could be easily imitated
c. It was technically too hard to "keep it up"
d. The system was not expensive enough
e. The system did not use enough leading edge technology

10. When manufacturers introduced 56K modems it forced makers of 33.6K modems to lower their prices. This is an example of:
a. Substitutes
b. Supplier Power
c. Buyer Power
d. Rivalry among firms
e. Barriers to entry

11. Bill Gates is quoted as saying that if technical progress in the automobile industry was as fast as technical progress in the computer industry a Cadillac would cost less than $10 and get over a thousand miles to the gallon. This is a result of:
a. Metcalfe's Law
b. The dramatic increase in software development productivity
c. The emergence of network computers
d. Moore's law
e. Microsoft being a monopoly

12. It is highly unlikely that a competitor can displace Microsoft Windows as the dominant operating system (OS) on personal computers because developers are only likely to develop products for the dominant OS, leaving competing OS with no applications. This is an example of:
a. Network externalities
b. Economies of scale
c. Price discrimination
d. Economies of scope
e. Congestion externalities

13. In 1914, industrial engineers argued that work should be designed such that "the laborer need only follow instructions, he need not stop to think". This is an example of:
a. Decentralization of decision rights
b. Centralization of decision rights
c. Monitoring systems
d. Output-based incentives
e. Effective use of specific knowledge

14. The main reason(s) that organizations are beginning to replace hierarchical databases with relational databases is that:
a. Computing power is much cheaper than before
b. It is easier to analyze data in relational databases
c. Relational databases are faster for routine transaction processing
d. A and B
e. All of the above

15. The dominant language for describing the <u>content</u> of web pages is:
a. Postscript
b. Hypertext Transfer Protocol (HTTP)
c. Hypertext Markup Language (HTML)
d. Structured Query Language (SQL)
e. HTTP and HTML

16. Fiber-Optic Distributed Data Interface (FDDI) is a technology used for high-speed communications links for the internet backbone. For these links it is important that network throughput is maximized and all devices get a predictable amount of access to the network. Therefore, the network layer (OSI layer 2) utilizes:
a. CSMA/CD technology
b. Ethernet technology
c. Token-passing protocols (similar to Token ring)
d. 10-base-T
e. 10-base-2

17. To create a digital signature on an e-mail message using a public-key cryptosystem, the following key is applied to a hashed version of the message before it is sent:
a. The public key of the sender
b. The private key of the sender
c. The public key of the receiver
d. The private key of the receiver
e. The public key of the sender, then the private key of the sender

18. The "Expense Tracking System" at the Tiger Creek Mill is best described as:
a. Enterprise resource planning
b. A decision support system
c. CAD/CAM
d. A JIT Inventory System
e. A data mining tool

19. The Pentium II places the level 2 cache in the same device package as the processor to maximize the speed of the interconnection. This cache is most likely a:
a. dynamic RAM
b. static RAM
c. EEPROM
d. DVD (digital video disc)
e. ROM

20. The major reason network PCs are likely to be cost effective in corporate environments is:
a. They save the cost of a disk drive
b. They save the cost of installing a Local Area Network
c. They reduce the cost of administering the network, PC hardware and software
d. Larry Ellison (CEO of Oracle) says they are cheaper
e. They prevent employees from spending the day downloading pornography from the web

1. (3 points) I like dogs. Therefore I have decided to use the word dog as my password on an Unix machine connected to the internet (note to exceedingly well informed people: assume that this machine does not use password shadowing). Briefly explain why this is a bad idea (even if people don't know I like dogs).

2. (3 points) Why do network administrators prefer star configuration networks?

3. (3 points) Why are RISC processors usually used in laser printers instead of CISC?

4. (3 points) What is the primary difference between general and specific knowledge?

5. (4 points) Producers of photographs would like to protect their intellectual property by including a digital "watermark" to uniquely identify the owner of a photograph. One way to implement this is to add additional data to the image that makes small changes in the color of very fine details of the original image (recognizable by a computer but not enough to be perceived by the human eye). What is a potential problem of this approach when applied to images that are designed to be on web pages or transmitted in other media with bandwidth constraints?

1. Eddie is a city employee whose job is to run a service facility for all the city vehicles in the town of Springfield. The Springfield garage is charged with maintaining a the city fleet which includes police cars, garbage trucks and regular sedans. Eddie's job is to maintain a specified level of availability (e.g. no more than 10% of the city vehicles in any class should be out of service) while minimizing cost to the city. To accomplish this Eddie has a staff of 100 mechanics (trade school educated with about 5 years of experience servicing cars on average), 20 supervisors (usually former mechanics with 10+ years of experience who also have a technical certification of their skill) plus an additional 20 or so administrative staff and senior management. All mechanics work in five person teams with one supervisor and all staff are paid a fixed wage. The facility has a 15% staff turnover rate which is normal for both private and public sector garages.

Costs are driven by the number of labor hours of mechanic time used on each vehicle and the amount of parts used. Workers have substantial flexibility in performing their work; they perform both diagnostic and repair work, and are responsible for selecting the parts they need. The diagnostic part is quite difficult and requires substantial problem solving skills and experience whereas the basic repair is well outlined in standard service manuals. Mechanics are also responsible for deciding whether repair a part (saving parts cost, but incurring labor hours) or replace a part. A computer system is available that tells the historical average repair labor hours for each type of repair on each type of vehicle based on the diagnosis of the problem.

Supervisors mainly watch to make sure that workers are working during their shift, consult on repairs when needed, and try to ensure repairs are done properly. A car which is not repaired properly will often return to the garage for the same problem again (although by random chance, some "returns" just happen regardless of repair quality) Unfortunately, unless the supervisor is present for the entire repair, it is difficult to judge the quality of the work when the car leaves the garage.

1. Eddie has hired you as a consultant to help him increase performance of his shop. Suppose Eddie were to implement the following system: have the supervisor evaluate each car and recommend a repair. The job is then assigned to the mechanic. The mechanic is then paid a bonus (or penalty) based on whether the repair is completed faster or slower than the computer system says the repair should take, but the base salary remains the same

a. What are the advantages of such a system over the previous organizational design? (5 points)

b. What are the disadvantages of such a system? (10 points)

c. What would you suggest they do to improve performance (you are free to use elements of the design described above). Be sure to describe organizational changes and information systems changes needed to support the new organization. Please be clear why you believe these changes will work. (10 points)

2. Open Database Connectivity (ODBC) is a standard which allows database systems to interoperate. The idea is that a user with one software package (say dBase IV) can use the ODBC facilities to access or write to another type of database (say Oracle). To become ODBC compliant, a database vendor needs to design ODBC drivers for their system. The ODBC drivers then provide the common communication system between database systems.

a. If this technology is widely adopted, who is likely to win and who is likely to lose?

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Must CIM be justified by faith alone?

Robert S. Kaplan

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"Managers need not–and should not–abandon the effort to justify computer-integrated manufacturing on financial grounds. Instead, they need ways to apply the DCF approach more appropriately."

Must CIM be justified by faith alone?

Robert S. Kaplan

When the Yamazaki Machinery Company in Japan installed an $18 million flexible manufacturing system, the results were truly startling: a reduction in machines from 68 to 18, in employees from 215 to 12, in the floor space needed for production from 103,000 square feet to 30,000, and in average processing time from 35 days to 1.5.[1] After two years, however, total savings came to only $6.9 million, $3.9 million of which had flowed from a one-time cut in inventory. Even if the system continued to produce annual labor savings of $1.5 million for 20 years, the project's return would be less than 10% per year. Since many U.S. companies use hurdle rates of 15% or higher and payback periods of five years or less, they would find it hard to justify this investment in new technology–despite its enormous savings in number of employees, floor space, inventory, and throughput times.

The apparent inability of traditional modes of financial analysis like discounted cash flow to justify investments in computer-integrated manufacturing (CIM) has led a growing number of managers and observers to propose abandoning such criteria for CIM-related investments. "Let's be more practical," runs one such opinion. "DCF is not the only gospel. Many managers have become too absorbed with DCF to the extent that practical strategic directional considerations have been overlooked."[2]

Faced with outdated and inappropriate procedures of investment analysis, all that responsible executives can do is cast them aside in a bold leap of strategic faith. "Beyond all else," they have come to believe, "capital investment represents an act of faith, a belief that the future will be as promising as the present, together with a commitment to making the future happen."[3]

But must there be a fundamental conflict between the financial and the strategic justifications for CIM? It is unlikely that the theory of discounting future cash flow is either faulty or unimportant. receiving $1 in the future is worth less than receiving $1 today. If a company, even for good strategic reasons, consistently invests in projects whose financial returns are below its cost of capital, it will be on the road to insolvency. Whatever the special values of CIM technology, they cannot reverse the logic of the time value of money.

Surely, therefore, the trouble must not lie in some unbreachable gulf between the logic of DCF and the nature of CIM but in the poor application of DCF to these investment proposals. Managers need not–and should not–abandon the effort to justify CIM on financial grounds. Instead, they need ways to apply the DCF approach more appropriately and to be more sensitive to the realities and special attributes of CIM.

Technical issues

The DCF approach most often goes wrong when companies set arbitrarily high hurdle rates for evaluating new investment projects. Perhaps they believe that high-return projects can be created by setting high rates rather than by making innovations in product and process technology or by cleverly building and exploiting a competitive advantage in the marketplace. In fact, the discounting function serves only to make cash flows received in the future equivalent to

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cash flows received now. For this narrow purpose—the only purpose, really, of discounting future cash flows—companies should use a discount rate based on the project's opportunity cost of capital (that is, the return available in the capital markets for investments of the same risk).

It may surprise managers to know that their real cost of capital can be in the neighborhood of 8%. (See Part I of the *Appendix* at the end of the article.) Double-digit hurdle rates that, in part, reflect assumptions of much higher capital costs are considerably wide of the mark. Their discouraging effect on CIM-type investments is not only unfortunate but also unfounded.

Companies also commonly underinvest in CIM and other new process technologies because they fail to evaluate properly all the relevant alternatives. Most of the capital expenditure requests I have seen measure new investments against a status quo alternative of making no new investments—an alternative that usually assumes a continuation of current market share, selling price, and costs. Experience shows, however, that the status quo rarely lasts. Business as usual does not continue undisturbed.

In fact, the correct alternative to new CIM investment should assume a situation of declining cash flows, market share, and profit margins. Once a valuable new process technology becomes available, even if one company decides not to invest in it, the likelihood is that some of its competitors will. As Henry Ford claimed, "If you need a new machine and don't buy it, you pay for it without getting it."[4] (For a more realistic approach to the evaluation of alternatives, see Part II of the *Appendix* at the end of the article.)

A related problem with current practice is its bias toward incremental rather than revolutionary projects. In many companies, the capital approval process specifies different levels of authorization depending on the size of the request. Small investments (under $100,000, say) may need only the approval of the plant manager; expenditures in excess of several million dollars may require the board of directors' approval. This apparently sensible procedure, however, creates an incentive for managers to propose small projects that fall just below the cut-off point where higher level approval would be needed. Over time, a host of little investments, each of which delivers savings in labor, material, or overhead cost, can add up to a less-than-optimal pattern of material flow and to obsolete process technology. (Part III of the *Appendix* shows the consequences of this incremental bias in more detail.)

Introducing CIM process technology is not, of course, without its costs. Out-of-pocket equipment expense is only the beginning. Less obvious are the associated software costs that are necessary for CIM equipment to operate effectively. Managers should not be misled by the expensing of these costs for tax and financial reporting purposes into thinking them operating expenses rather than investments. For internal management purposes, software development is as much a part of the investment in CIM equipment as the physical hardware itself. Indeed, in some installations, the programming, debugging, and prototype development may cost more than the hardware.

There are still other initial costs: site preparation, conveyors, transfer devices, feeders, parts orientation, and spare parts for the CIM equipment. Operating and maintenance personnel must be retrained and new operating procedures developed. Like software development, these tax-deductible training and education costs are part of the investment in CIM, not an expense of the periods in which they happen to be incurred.

Further, as some current research has shown, noteworthy declines in productivity often accompany the introduction of new process technology.[5] These productivity declines can last up to a year, even longer when a radical new technology like CIM is installed. Apparently, the new equipment introduces severe and unanticipated process disruptions, which lead to equipment breakdowns that are higher than expected; to operating, repair, and maintenance problems; to scheduling and coordination difficulties; to revised materials standards; and to old-fashioned confusion on the factory floor.

We do not yet know how much of the disruption is caused by inadequate planning. After investing considerable effort and anguish in the equipment acquisition decision, some companies no doubt revert to business as usual while waiting for the new equipment to arrive.

Whatever the cause, the productivity decline is particularly ill timed since it occurs just when a company is likely to conduct a postaudit on whether it is realizing the anticipated savings from the new equipment. Far from achieving anticipated savings, the postaudit will undoubtedly reveal lower output and higher costs than predicted.

Tangible benefits

The usual difficulties in carrying out DCF analysis – choosing an appropriate discount rate and evaluating correctly all relevant investment alternatives – apply with special force to the consideration of investments in CIM process technology. The greater flexibility of CIM technology, which allows it to be used for successive generations of products, gives it a longer useful life than traditional process investments. Because its benefits are likely to persist longer, overestimating the relevant discount rate will penalize CIM investments disproportionately more than shorter lived investments. The compounding effect of excessively high annual interest rates causes future cash flows to be discounted much too severely. Further, if executives arbitrarily specify short payback periods for new investments, the effect will be to curtail more CIM investments than traditional bottleneck-relief projects.

But beyond a longer useful life, CIM technology provides many additional benefits – better quality, greater flexibility, reduced inventory and floor space, lower throughput times, experience with new technology – that a typical capital justification process does not quantify. Financial analyses that focus too narrowly on easily quantified savings in labor, materials, or energy will miss important benefits from CIM technology.

Inventory savings

Some of these omissions can be easily remedied. The process flexibility, more orderly product flow, higher quality, and better scheduling that are typical of properly used CIM equipment will drastically cut both work-in-process (WIP) and finished goods inventory levels. This reduction in average inventory levels represents a large cash inflow at the time the new process equipment becomes operational. This, of course, is a cash savings that DCF analysis can easily capture.

Consider a product line for which the anticipated monthly cost of sales is $500,000. Using existing equipment and technology, the producing division carries about three months of sales in inventory. After investing in flexible automation, the division heads find that reduced waste, scrap, and rework, greater predictability, and faster throughput permit a two-thirds reduction in average inventory levels. (This is not an unrealistic assumption: Murata Machinery Ltd. has reported that its FMS installation permitted a two-thirds reduction in workers, a 450% increase in output, and a 75% cut in inventory levels.[6])

Pruning inventory from three months to one month of sales produces a cash inflow of $1 million in the first year the system becomes operational. If sales increase 10% per year, the company will enjoy increased cash flows from the inventory reductions in all future years too – that is, if the cost of sales rises to $550,000 in the next year, a two-month reduction

Example of an FMS justification analysis

With the following analysis, one U S manufacturer of air-handling equipment justified its investment in an FMS installation for producing a key component·

1
Internal manufacture of the component is essential for the division's long-term strategy to maintain its capability to design and manufacture a proprietary product.

2
The component has been manufactured on mostly conventional equipment—some numerically controlled—with an average age of 23 years. To manufacture a product in conformance with current quality specifications, the company must replace this equipment with new conventional equipment or advanced technology.

3
The alternatives are:
Conventional or numerically controlled stand-alone.
Transfer line
Machining cells.
FMS.

4
FMS compares with conventional technology as Table A shows

5
Intangible benefits include virtually unlimited flexibility for FMS to modify mix of component models to the exact requirements of the assembly department.

6
The financial analysis for a project life of ten years compares the FMS with conventional technology (static sales assumptions, constant, or base-year, dollars) as Table B shows.

7
With dynamic sales assumptions showing expected increases in production volume, the annual operating savings will double in future years and the financial yield (still using constant, base-year, dollars) will increase to more than 17% per year.

On the basis of this analysis and recognizing the value of the intangible item (5), which had not been incorporated formally, the company selected the FMS option.

Table A

	Conventional equipment	FMS
Utilization	30 %-40 %	80 %-90 %
Number of employees needed (including indirect workers, such as those who do materials handling, inspection, and rework)*	52	14
Reduced scrap and rework	–	$ 60,000 annually
Inventory	$ 2,000,000	$ 1,100,000†
Incremental investment	–	$ 9,200,000

*Each employee costs $36,000 a year in wages and fringe benefits.
†Inventory reductions because of shorter lead times and flexibility.

Table B

Year	Investment	Operating savings	Tax savings ITC and ACRS depreciation	After-tax cash flow 50 %
0	$ 9,200	$ 900‡	$ 920	$ –7,380
1		1,428§	1,311	1,370¶
2		1,428	1,923	1,675
3		1,428	1,835	1,632
4		1,428	1,835	1,632
5		1,428	1,835	1,632
6		1,428		714
7		1,428		714
8		1,428		714
9		1,428		714
10		1,428		714

After-tax yield 11.1 %.
Payback period during year 5.

‡$ 900 = Inventory reduction at start of project.

§$ 1,428 = 38 fewer employees at $36,000/year + $60,000 scrap and rework savings.

¶$ 1,370 = (1,428) (1 0.50) + (1,311) (0.50)

in inventory saves an additional $100,000 that year, $110,000 the year after, and $121,000 the year after that.

Less floor space

CIM also cuts floor-space requirements. It takes fewer computer-controlled machines to do the same job as a larger number of conventional machines. Also, the factory floor will no longer be used to store inventory. Recall the example of the Japanese plant that installed a flexible manufacturing system and reduced space requirements from 103,000 to 30,000 square feet. These space savings are real, but conventional financial accounting systems do not measure their value well—especially if the building is almost fully depreciated or was purchased years before when price levels were lower. Do not, therefore, look to financial accounting systems for a good estimate of the cost or value of space. Instead, compute the estimate in terms of the opportunity cost of new space: either its square-foot rental value or the annualized cost of new construction.

Many companies that have installed CIM technology have discovered a new factory inside their old one. This new "factory within a factory" occupies the space where excessive WIP inventory and infrequently used special-purpose machines used to sit. Eliminating WIP inventory and rationalizing machine layout can easily lead to savings of more than 50% in floor space. In practice, these savings have enabled some companies to curtail plant and office expansion programs and, on occasion, to fold the operations of a second factory (which could then be sold off at current market prices) into the reorganized original factory.

Higher quality

Greatly improved quality, defined here as conformance to specifications, is a third tangible benefit from investment in CIM technology. Automated process equipment leads directly to more uniform production and, frequently, to an order-of-magnitude decline in defects. These benefits are easy to quantify and should be part of any cash flow analysis. Some managers have seen five- to tenfold reductions in waste, scrap, and rework when they replaced manual operations with automated equipment.

Further, as production uniformity increases, fewer inspection stations and fewer inspectors are required. If automatic gauging is included in the CIM installation, virtually all manual inspection of parts can be eliminated. Also, with 100% continuous automated inspection, out-of-tolerance parts are detected immediately. With manual systems, the entire lot of parts to be produced before a problem is detected would need to be reworked or scrapped.

These capabilities lead, in turn, to significant reductions in warranty expense. When General Electric automated its dishwasher operation, for example, its service call rate fell 50%. Designing manufacturability into products, making the production process more reliable and uniform, and improving automated inspection can all contribute to major cash flow savings. Although it may be hard to estimate these savings out to four or five significant digits, it would be grossly wrong to assume that the benefits are zero. We must overcome the preference of accountants for precision over accuracy, which causes them to ignore benefits they cannot quantify beyond one or two digits of accuracy.

We can estimate still other tangible benefits from CIM. John Shewchuk of General Electric claims that accounts receivable can be reduced by eliminating the incidence of customers who defer payment until quality problems are resolved.[7] Consider too that because improved materials flow can reduce the need for forklift trucks and operators, factories will enjoy a large cash flow saving from not having to acquire, maintain, repair, and operate so many trucks. All these calculations belong in a company's capital justification process.

Intangible benefits

Other benefits of CIM include increased flexibility, faster response to market shifts, and greatly reduced throughput and lead times. These benefits are as important as those just discussed but much harder to quantify. We may not be sure how many zeros should be in our benefits estimate (are they to be measured in thousands or millions of dollars?) much less which digit should be first. The difficulty arises in large part because these benefits represent revenue enhancements rather than cost savings. It is fairly easy to get a ballpark estimate for percentage reductions in costs already being incurred. It is much harder to quantify the magnitude of revenue enhancement expected from features that are not already in place.

Greater flexibility

The flexibility that CIM technology offers takes several forms. The benefits of economies of scope—that is, the potential for low-cost production

of high-variety, low-volume goods—are just beginning to flow from FMS environments as early adopters of the technology start to service after-market sales for discontinued models on the same equipment used to produce current high-volume models. We are also beginning to see some customized production on the same lines used for standard products.

Beyond these economy-of-scope applications, CIM's reprogramming capabilities make it possible for machines to serve as backups for each other. Even if a machine is dedicated to a narrow product line, it can still replace lost production during a second or a third shift when a similar piece of equipment, producing quite a different product, breaks down.

Further, by easily accommodating engineering change orders and product redesigns, CIM technology allows for product changes over time. And, if the mix of products demanded by the market changes, a CIM-based process can respond with no increase in costs. The body shop of one automobile assembly plant, for example, quickly adjusted its flexible, programmed spot-welding robots to a shift in consumer preference from the two-door to the four-door version of a certain car model. Had the line been equipped with nonprogrammable welding equipment, the adjustment would have been far more costly.

CIM's flexibility also gives it usefulness beyond the life cycle of the product for which it was purchased. True, in the short run, CIM may perform the same functions as less expensive, inflexible equipment. Many benefits of its flexibility will show up only over time. Therefore, it is difficult to estimate how much this flexibility will be worth. Nonetheless, as we shall see, even an order-of-magnitude estimate may be sufficient.

Shorter throughput & lead time

Another seemingly intangible benefit of CIM is the great reductions it makes possible in throughput and lead time. At the Yamazaki factory described at the beginning of this article, average processing time per work piece fell from 35 to 1.5 days. Other installations, including Yamazaki's Mazak plant in Florence, Kentucky, have reported similar savings, ranging from a low of 50% reduction in processing time to a maximum of nearly 95%. To be sure, some of the benefits from greatly reduced throughput times have already been incorporated in our estimate of savings from inventory reductions. But there is also a notable marketing advantage in being able to meet customer demands with shorter lead times and to respond quickly to changes in market demand.

Increased learning

Some investments in new process technology have important learning characteristics. Thus, even if calculations of the net present value of their cash flows turn up negative, the investments can still be quite valuable by permitting managers to gain experience with the technology, test the market for new products, and keep a close watch on major process advances.

These learning effects have characteristics similar to buying options in financial markets. Buying options may not at first seem like a favorable investment, but quite small initial outlays may yield huge benefits down the line. Similarly, were a company to invest in a risky CIM-related project, it could reap big gains should the technology provide unexpected competitive advantages in the future. Moreover, given the rapid pace of technological change and the advantages of being an early market participant, companies that defer process investments until the new technology is well established will find themselves far behind the market leaders. In this context, the decision to defer investment is often a decision not to be a principal player in the next round of product or process innovation.

The companies that in the mid-1970s invested in automatic and electronically controlled machine tools were well positioned to exploit the microprocessor-based revolution in capabilities—much higher performance at much lower cost—that hit during the early 1980s. Because operators, maintenance personnel, and process engineers were already comfortable with electronic technology, it was relatively simple to retrofit existing machines with powerful microelectronics. Companies that had earlier deferred investment in electronically controlled machine tools fell behind: they had acquired no option on these new process technologies.

The bottom line

Although intangible benefits may be difficult to quantify, there is no reason to value them at zero in a capital expenditure analysis. Zero is, after all, no less arbitrary than any other number. Conservative accountants who assign zero values to many intangible benefits prefer being precisely wrong to being vaguely right. Managers need not follow their example.

Author's note: Especially helpful comments on the preliminary draft were made by Robin Cooper and Robert Hayes (Harvard Business School), Alan Kantrow (*Harvard Business Review*), George Kuper (Manufacturing Studies Board), and Scott Richard and Jeff Williams (Carnegie-Mellon).

One way to combine difficult-to-measure benefits with those more easily quantified is, first, to estimate the annual cash flows about which there is the greatest confidence: the cost of the new process equipment and the benefits expected from labor, inventory, floor space, and cost-of-quality savings. If at this point a discounted cash flow analysis—done with a sensible discount rate and a consideration of all relevant alternatives—shows a CIM investment to have a positive net present value, well and good. Even without accounting for the value of intangible benefits, the analysis will have gotten the project over its financial hurdle. If the DCF is negative, however, then it becomes necessary to estimate how much the annual cash flows must increase before the investment does have a positive net present value.

To see how one manufacturer justified its investment in FMS, turn to the insert entitled "Example of an FMS Justification Analysis."

Suppose, for example, that an extra $100,000 per year over the life of the investment is sufficient to give the project the desired return. Then management can decide whether it expects heightened flexibility, reduced throughput and lead times, and faster market response to be worth at least $100,000 per year. Should the company be willing to pay $100,000 annually to enjoy these benefits? If so, it can accept the project with confidence. If, however, the additional cash flows needed to justify the investment turn out to be quite large—say $3 million per year—and management decides the intangible benefits of CIM are not worth that sum, then it is perfectly sensible to turn the investment down.

Rather than attempt to put a dollar tag on benefits that by their nature are difficult to quantify, managers should reverse the process and estimate first how large these benefits must be in order to justify the proposed investment. Senior executives can be expected to judge that improved flexibility, rapid customer service, market adaptability, and options on new process technology may be worth $300,000 to $500,000 per year but not, say, $1 million. This may not be exact mathematics, but it does help put a meaningful price on CIM's intangible benefits.

As manufacturers make critical decisions about whether to acquire CIM equipment, they must avoid claims that such investments have to be made on faith alone because financial analysis is too limiting. Successful process investments must yield returns in excess of the cost of capital invested. That is only common sense. Thus the challenge for managers is to improve their ability to estimate the costs and benefits of CIM, not to take the easy way out and discard the necessary discipline of financial analysis.

References

1 This example has appeared in several articles on strategic justification for flexible automation projects. Clifford Young of Arthur D. Little has traced the example to *American Market/Metalworking News*, October 26, 1981. Other examples of the labor, machinery, and throughput savings from flexible manufacturing system installations are presented in Anderson Ashburn and Joseph Jablonowski, "Japan's Builders Embrace FMS," *American Machinist*, February 1985, p. 83.

2 John P. Van Blois, "Economic Models: The Future of Robotic Justification," Thirteenth ISIR/Robots 7 Conference, April 17-21, 1983 (available from Society of Manufacturing Engineers, Dearborn, Michigan).

3 Robert H. Hayes and David A. Garvin, "Managing As If Tomorrow Mattered," HBR May-June 1982, p. 70.

4 Quoted in John Shewchuk, "Justifying Flexible Automation," *American Machinist*, October 1984, p. 93.

5 See Robert H. Hayes and Kim B. Clark, "Exploring the Sources of Productivity Differences at the Factory Level," in *The Uneasy Alliance: Managing the Productivity-Technology Dilemma*, ed. Kim B. Clark, Robert H. Hayes, and Christopher Lorenz (Boston: Harvard Business School Press, 1985), and Bruce Chew, "Productivity and Change: Understanding Productivity at the Factory Level," Harvard Business School Working Paper (1985).

6 "Japan's Builders Embrace FMS," *American Machinist*, February 1985, p. 83.

7 John Shewchuk, "Justifying Flexible Automation."

[See the Appendix on page 94.]

Appendix

Getting the numbers right

Part I
The cost of capital

A company always has the option of repurchasing its common shares or retiring its debt. Therefore, managers can estimate the cost of capital for a project by taking a weighted average of the current cost of equity and debt at the mix of capital financing typical in the industry. Extensive studies of the returns to investors in equity and fixed-income markets during the past 60 years show that from 1926 to 1984 the average total return (dividends plus price appreciation) from holding a diversified portfolio of common stocks was 11.7% per year. This return already includes the effects of rising price levels. Removing the effects of inflation puts the real (after-inflation) return from investments in common stocks at about 8.5% per year (see *Table A*).*

These historical estimates of 8.5% real (or about 12% nominal) are, however, overestimates of the total cost of capital. From 1926 to 1984, fixed-income securities averaged nominal before-tax returns of less than 5% per year. Taking out inflation reduces the real return (or cost) of high-grade corporate debt securities to about 1.5% per year. Even with recent increases in the real interest rate, a mixture of debt and equity financing produces a total real cost of capital of less than 8%.

Many corporate executives will, no doubt, be highly skeptical that their real cost of capital could be 8% or less. Their disbelief probably comes from making one of two conceptual errors, perhaps both. First, executives often attempt to estimate their current cost of capital by looking at their accounting return on investment – that is, the net income divided by the net invested capital – of their divisions or corporations. For many companies this figure can be in the 15% to 25% range.

There are several reasons, however, why an accounting ROI is a poor estimate of a company's real cost of capital. The accounting ROI figure is distorted by financial accounting conventions such as depreciation method and a variety of capitalization and expense decisions. The ROI figure is also distorted by management's failure to adjust both the net income and the invested capital figures for the effects of inflation, an omission that biases the accounting ROI well above the company's actual real return on investment.

The second conceptual error that makes an 8% real cost of capital sound too low is implicitly to compare it with today's market interest rates and returns on common stocks. These rates incorporate expectations of current and future inflation, but the 8.5% historical return on common stocks and the less than 2% return on fixed-income securities are *real* returns, after the effects of inflation have been netted out.

Now it is possible, of course, to do a DCF analysis by using nominal market returns as a way of estimating a company's cost of capital. In fact, this may even be desirable when you are doing an after-tax cash flow analysis since one of the important cash flows being discounted is the nominal tax depreciation shield from new investments. I have, however, seen many a company go seriously wrong by using a nominal discount rate (say in excess of 15%) while it was assuming level cash flows over the life of their investments.

Consider, for example, the data in *Table B*, which is excerpted from an actual capital authorization request. Notice that all the cash flows during the ten years of the project's expected life are expressed in 1977 dollars, even though the company used a 20% discount rate on the cash flows of the several investment alternatives. This assumption of a 20% cost of capital most likely arose from a prior assumption of a real cost of capital of about 10% and an expected inflation rate of 10% per year. But if it believed that inflation would average 10% annually over the life of the project, the company should also have raised the assumed selling price and the unit costs of labor, material, and overhead by their expected price increases over the life of the project.

It is inconsistent to assume a high rate of inflation for the interest rate used in a DCF calculation but a zero rate of price change when you are estimating future net cash flows from an investment. Naturally, this inconsistency – using double-digit discount rates but level cash flows – biases the analysis toward the rejection of new investments, especially those yielding benefits five to ten years into the future. Compounding excessively high interest rates will place a low value on cash flows in these later years: a 20% interest rate, for example, discounts $1.00 to $.40 in five years and to $.16 in ten years. If companies use discount rates derived from current market rates of return, then they must also estimate rates of price and cost changes for all future cash flows.

Table A **Annual return series 1926-1984**

Mean annual returns

Series	1926-1984	1950-1984	1975-1984
Common stocks	11.7%	12.8%	14.7%
Long-term corporate bonds	4.7	4.5	8.4
U.S. Treasury bills	3.4	5.1	9.0
Inflation (CPI)	3.2	4.4	7.4

Real annual returns net of inflation

Series	1926-1984	1950-1984	1975-1984
Common stocks	8.5%	8.4%	7.3%
Long-term corporate bonds	1.5	0.1	1.0
U.S. Treasury bills	0.2	0.6	1.6

Part II
Measuring alternatives

Look again at the capital authorization request in *Table B*. The cash flows from alternative 1 assume a constant level of sales during the next ten years; the cash flows from alternative 5 show a somewhat higher level of sales based on a small increase in market share. The difference in sales revenue as currently projected, however, is not all that great. Only if managers anticipate a steady decrease in market share and sales revenue for alternative 1, a decrease occasioned by domestic or international competitors adopting the new production technology, would alternative 5 show a major improvement over the status quo.

Obviously, not all investments in new process technology are investments that should be made. Even if competitors adopt new technology and profits erode over time, a company may still find that the benefits from investing would not compensate for its costs. But either way, the company should rest its decision on a correct reading of what is likely to happen to cash flows when it rejects a new technology investment.

Table B **Example of a capital authorization request***

Alternative 1 **Rebuild present machines**

Year	1977	1978	1979	1980	1981	...	1986
Sales	$6,404	$6,404	$6,404	$6,404	$6,404	...	$6 404
Cost of sales:							
Labor	168	168	168	168	168		168
Material	312	312	312	312	312	.	312
Overhead	1,557	1,557	1,557	1,557	1,557		1,557

Alternative 5 **Purchase all new machines**

Year	1977	1978	1979	1980	1981	...	1986
Sales	$6,404	$6,724	$7,060	$7,413	$7,784	..	$7,784
Cost of sales:							
Labor	167	154	148	152	152	..	152
Material	312	328	344	361	380		380
Overhead	1,557	1440	1,390	1,423	1,423	...	1,423

*Adapted from Robert S. Kaplan and Glen Bingham *Wilmington Tap and Die.* Case 1?5-124 (Boston Harvard Business School, 1985)

Part III
Piecemeal investment

Each year, a company or a division may undertake a series of small improvements in its production process – to alleviate bottlenecks, to add capacity where needed, or to introduce islands of automation based on immediate and easily quantified labor savings. Each of these projects, taken by itself, may have a positive net present value. By investing on a piecemeal basis, however, the company or division will never get the full benefit of completely redesigning and rebuilding its plant. Yet the pressures to go forward on a piecemeal basis are nearly irresistible. At any point in time, there are many annual, incremental projects scattered about from which the investment has yet to be recovered. Thus, were management to scrap the plant, its past incremental investments would be shown to be incorrect.

One alternative to this piecemeal approach is to forecast the remaining technological life of the plant and then to enforce a policy of accepting no process improvements that will not be repaid within this period. Managers can treat the money that otherwise would have been invested as if it accrued interest at the company's cost of capital. At the end of the specified period, they could abandon the old facility and build a new one with the latest relevant technology.

Although none of the usual incremental process investments may have been incorrect, the collection of incremental decisions could have a lower net present value than the alternative of deferring most investment during a terminal period, earning interest on the unexpended funds, and then replacing the plant. Again, the failure to evaluate such global investment is not a limitation of DCF analysis. It is a failure of not applying DCF analysis to all the feasible alternatives to annual, incremental investment proposals.

*Roger G. Ibbotson and Rex A. Sinquefield, *Stocks, Bonds, Bills and Inflation. The Past and the Future* (Charlottesville, Va., Financial Analysts Research Foundation, 1982). The author has updated this study for returns earned during 1982-1984.

This estimate should be adjusted up or down, depending on whether the project's risk is above or below the risk of the average project in the market. A detailed discussion of appropriate risk adjustments is beyond the scope of this article. Good treatments can be found in David W. Mullins, Jr., "Does the Capital Asset Pricing Model Work?" HBR January-February 1982, p. 105, and in chap. 7-9 in Richard Brealey and Stewart Myers, *Principles of Corporate Finance*, 2d ed. (New York McGraw-Hill, 1984)

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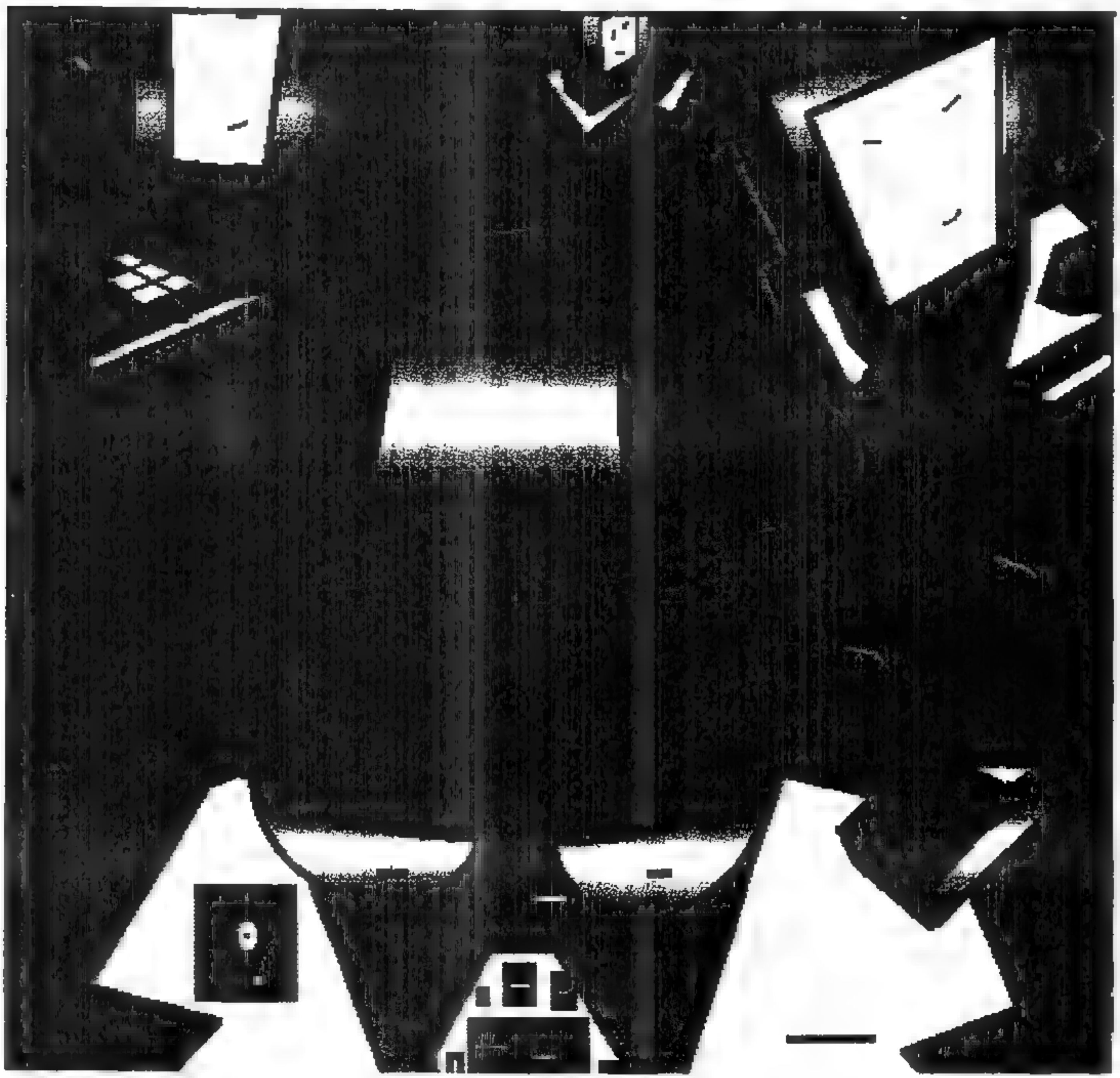
WHARTON

Evaluation of STRATEGIC



INVESTMENTS in Information Technology

Developing a strategic application—intended to make a company more flexible, more responsive to customer needs, or more able to adapt to rapidly changing conditions in the competitive environment—is fundamentally different from investments undertaken to automate the back office to reduce expenses or increase capacity. Alternative techniques for evaluating the business case for strategic systems have been developed and have worked well in practice. Several cases are presented here.

Eric K. Clemons

For investment decisions, evidence has shown that businesses have difficulty in evaluating when to use information technology. This problem really is fundamental to the continuing application of information technology in business and government. We have made far more progress in determining how a system should be built; software professionals have readily adopted progress in algorithm and data structure design, significantly improving application performance. We have made far more progress in determining how to make systems reliable; again, the data-processing community has adopted (sometimes slowly) progress in available tools and languages, and in management of software development, statistical quality control, and testing, to produce systems of greater quality. We have made even more progress in the soft areas such as interface design. Of course, the most important question is determining what to build. In this area there has been very little formal progress, and even less has been published by the research community.

The increasing competitive impact that information systems are having, make information technology a new concern of senior management. Strategic application of information technology, for order entry, for travel agent reservation systems, for securities trader support, or just for organizational infrastructure are by now part of the executive's folklore. Calls go out from the executive suite for information systems that will deliver sustainable competitive advantage. How can opportunities for these systems be evaluated? How should a senior executive make the decision to invest in a strategic program based on information technology?

Many decisions that clearly appear to have been correct from today's perspective, were neither easy nor obvious at the time that they were reached. American Airlines's travel agent reservation system, Sabre, is today one of the most widely cited examples of a competitive use of information technology. In September 1988, when American's parent, AMR, announced that it would consider bids for Sabre, Wall Street placed a value of $1.5 billion on Sabre—at a time when the market capitalization of AMR itself was only $2.9 billion. In a dozen years, the reservation system had come to account for over half of AMR's operating income, and its market value had become greater than that of the airline's core business.[1] And yet when American was first considering the development of Sabre, the decision was neither easy nor obvious. American's major competitor, United Airlines, had developed its own system, Apollo, first, but stopped selling it to agencies after a small initial rollout; American responded vigorously, and United's market share has lagged behind American's ever since. Perhaps more striking is the number of carriers that chose not to participate with American when initially offered the opportunity.

Clearly, if given another chance, these carriers would not be willing to allow control of reservation systems to remain in the hands of a competitor. This is reflected by the structure chosen for travel agent reservation systems in the rest of the world. Perhaps because of the experience in the United States, airlines in Europe and the Far East, have formed consortia—Galileo, Amadeus, Abacus—to own and operate these systems.

These decisions are not getting any safer or easier: In the United States, Chemical Bank's aggressive launch of *Pronto*, its electronic home-banking offering, ultimately resulted in almost no return to show for its multi-million dollar investment.[2] And investments directed toward strategic positioning can now involve astronomical sums. National Westminster Bank, a major United Kingdom clearing bank, is replacing its entire information technology infrastructure at an estimated cost of several hundred million dollars [3]! Work has already begun on rewriting hundreds of the bank's 12,500 computer programs.

These decisions are difficult because available techniques have not kept pace with the needs of current practice. Evaluation of a system's development based on potential competitive impact is fundamentally different from evaluation based on cost. This is far more complex than selecting hardware based on throughput and the cost of MIPS, or than justifying a purchase because the curve for transaction processing requirements is approaching current capacity. It is also more complex than trading off the cost of the system against the reduction in operating cost attributable to automation. This problem with system evaluation is just one specific example of a more pervasive problem noted by Robert Kaplan [13,18,19]: Discounted cash flow, and other analytic techniques taught to generations of M.B.A. students, are consistently misused when applied to strategic investment decisions. Much of Kaplan's criticism is directed toward the desire for precision, at the expense of accuracy; when decision makers cannot precisely estimate benefits accurately—all too common when evaluating the competitive impact of innovative applications—hard-headed financial analysts

[1] Sabre and Apollo have become essential to all airlines. Since these reservation systems are used by virtually all major travel agencies, and since these agencies account for about 80 per cent of the airlines' traffic, it is essential for all carriers to be listed in all major systems. As this became appreciated by American and Apollo, they were able to charge very considerable fees for the services they provide to other carriers. This is described in some detail in [10].

[2] In fact, ultimately the bank was forced to take a write-down of tens of millions of dollars on its home-banking service. According to Industry estimates Chemical spent $20 million developing *Pronto*, and Chemical and AT&T subsequently spent another $50 million developing Covidea, a videotex service [17].

often force the use of zero as the value of these benefits. These same analysts frequently use unjustifiably high estimates for the cost of capital as a surrogate for dealing with uncertainty in a meaningful way.

There are other, more fundamental difficulties with strategic innovations, not tied to problems with accounting. Often the strategic programs being undertaken have extremely long lead times. In particular, during the time between making the investment decision and the strategic program coming on-line, the environment itself may have changed, confounding analysis and adding considerable uncertainty. This problem is particularly acute in rapidly changing, newly deregulated industries. And often the technologies involved are so new that not even the experts are certain about what their implications will be. The affected managers are often without the experience, information, or methodology needed to evaluate their programs.

The problems of evaluating investments in factory automation are illustrative. This should not be viewed as new technology for making *today's* automobiles, but rather as new technology for making *tomorrow's* automobiles. This requires assumptions about how manufacturing engineering will advance to exploit new manufacturing technology, and how marketing will be able to exploit the ability to make more limited runs—perhaps production runs of size one—to fill specific demands from individual customers. What are the cost implications of these improved manufacturing engineering methods? Will the marketplace reward greater flexibility with increased margins or market share? How can these effects be predicted with any accuracy, or even measured after implementation?

Most importantly, the programs themselves, if successful, may so dramatically alter the business environment that their very success engenders much uncertainty. Current financial projections are consequently nearly meaningless. The Chicago Mercantile Exchange has recently announced GLOBEX, an electronic, screen-based system for after-hours trading. How will GLOBEX affect the profitability of floor traders on the Merc? Big Bang, the deregulation of the London Stock Exchange, replaced a comfortable, club-like trading floor with an efficient electronic market, allowing London to capture market share from Continental exchanges, and even to recapture some trading volume lost to American markets [10]. Unfortunately, in this efficient market it has been extremely difficult—some would say impossible—for the Exchange's member firms to deal profitably, and the annual running rate of their losses is estimated to exceed £1 billion. Should it have been possible to estimate in advance the effects of this efficiency on its members' profitability?

When the costs and the risks are high enough, it is tempting for managers to delay action until the last estimate is quantified and the last analysis is complete. Unfortunately, in many cases this is impossible. The numbers will never be known with sufficient precision or certainty, and the calculations will not be sufficiently unambiguous to enable the executive to decide to take action without risk to the firm or to his or her career. As David Freedman notes in a recent article, "assigning a hard value to a strategic information system is a slippery task that is unlikely to lead to more effective decision making." In fact, he goes on to add, "insisting on a dollars-and-cents analysis of every project can seriously damage an organization's competitiveness." [16]. In the same article, Don Lucas, vice president of information systems of Otis Elevator, adds, "We've learned that it is very difficult to quantify the value of some strategic systems."

Of course, these investment decisions do get made. Fortunately, there are some guidelines and principles that executives can use to structure their analysis of strategic information systems investments. Based on our own study of a range of such analyses with major corporations in the United States and abroad, including some in which we directly participated, we offer the following suggestions:

LESSON ONE

[illegible]

Even when it is not possible to compute explicit, precise values associated with embarking on strategic programs, it may be possible to estimate, with enough accuracy, to rank alternatives. Just as importantly, it may be possible to structure the analysis carefully so that the preferred alternative becomes clear, even without numerical estimates.

Bloomberg Financial[3]

The problem: *Merrill Lynch owns a minority share in Bloomberg Financial Markets, probably the premier analytics package available to the Street for support of fixed-income investments (bonds). Bloomberg gets real-time price feeds for corporate bond offerings through Merrill Lynch and for government bonds through primary dealers; additional feeds from derivatives markets provide prices for bond futures and for interest rate futures.*[4] *Analytic packages then allow a trader to perform a wide variety of functions:*

- *Finding the most attractively priced instruments*
- *Finding the most appropriate instruments to cover a short position*[5]
- *Designing a hedge, through short sales, bond futures, or interest rate futures contracts, and displaying the results of the hedge graphically, both for individual investments and an entire portfolio.*

[3]Material for this section comes from *The Wall Street Journal* [24,25] and private conversations with Merrill Lynch and Bloomberg Financial Markets personnel (New York, September and October, 1980).

Merrill's bond traders and salesmen use the system, and Merrill's most senior executives were deciding whether or not to allow Bloomberg to sell to their largest competitors. Should Bloomberg be unchained and allowed to sell?

An argument can be made both for and against selling the system to competitors.

Con: Merrill may make more money selling bonds or trading for its own account using the system when competitors do not have it.

Additionally, the fixed-income market for corporate debt, unlike the market for corporate equities, lacks a central marketplace such as the New York Stock Exchange. As additional firms begin to feed their prices to Bloomberg, using Bloomberg as an electronic marketplace, and as pricing information thereby improves, the market will become more efficient. Spreads will narrow, and margins for bond traders will deteriorate.[6]

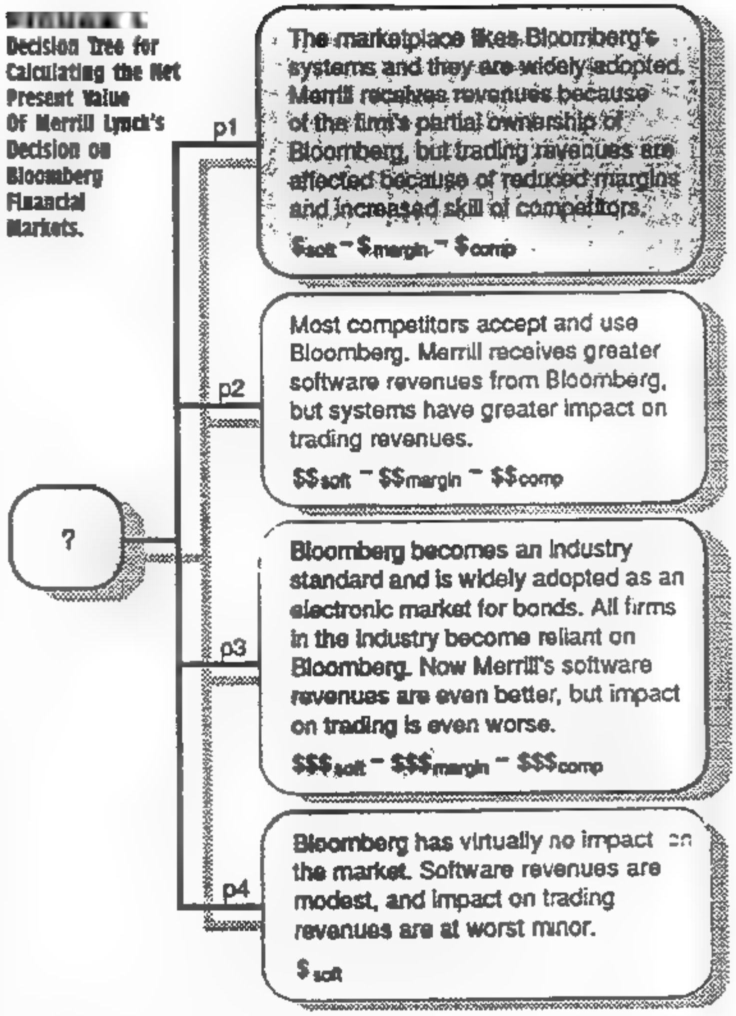
Pro: If we do not do it, someone else will. The effect on the market will be the same, but we will forgo our chance to make a significant profit on our investment in Bloomberg. And it is difficult to demonstrate that our traders or salesmen are doing any better than competitors because of the system.

Con: It is always difficult to demonstrate soft benefits from a support system.

And it really does not matter how profitable the business potentially can be! Merrill is a securities house, not a software house. One of Merrill's country heads said to me, in essence, "If the time ever comes when we have to replace our trading income with software revenues, I for one say 'It's time to fold this old trading house and die!'"

Analysis: *The analysis needed to compute the net present value [NPV] of the decision to allow Bloomberg to market more aggressively can be structured as shown in the decision tree in Figure 1. Only those outcomes related to the decision to market are shown in the tree. If the systems are offered, and the marketplace likes them, Merrill Lynch will make money on its investment in Bloomberg. If the marketplace response is very strong, Merrill stands to make a great deal of money letting Bloomberg sell. And if the marketplace moves toward use of Bloomberg as a standard electronic market for corporate debt, resulting in nearly universal adoption, Merrill may find that its investment in Bloomberg Financial Markets was very*

FIGURE 1.
Decision Tree for Calculating the Net Present Value Of Merrill Lynch's Decision on Bloomberg Financial Markets.



[4]Futures contracts represent an obligation between two parties to trade a commodity, security, or other item at a later time (the expiration date) and at a prearranged price. Futures contracts originally evolved as a means of managing risk for producers and consumers of commodities. Farmers could lock in an assured price for their harvest by selling futures, and bakers could protect themselves against unanticipated price changes by buying these futures contracts. Of course, speculators also find commodities futures attractive. Financial futures have similar uses: A manufacturer that knows of a future need for foreign currency to pay suppliers can hedge with a currency future. And a bank with bonds or fixed interest rate loans may protect itself against interest rate changes with futures contracts.

[5]A short position results when an investor sells securities he or she does not yet own. It ultimately will be necessary for the investor to cover this position by buying back these securities at a later time. Investors will normally sell a security short in anticipation of a drop in its price.

[6]Spreads represent the difference between the price at which dealers are willing to buy and sell securities; they provide much of the profits earned by bond dealers. And there is a large body of evidence that indicates that as markets become more transparent and prices become more widely known to traders, spreads are reduced.

profitable indeed! Of course, in this final scenario, as the market becomes more transparent and more efficient, Merrill's bond-trading operations may earn less, but even this is uncertain; Wall Street's experience with deregulation of commissions on the New York Stock Exchange in 1975 indicates that reduction in trading costs can increase trading volumes to such an extent that profits are actually increased.

It would appear that this is an extremely difficult financial analysis. It is necessary to determine probabilities of each of four outcomes: ranging from extremely limited marketplace response to widespread adoption as an industry standard for an electronic market for corporate bonds. It is then necessary to estimate the associated beneficial and negative impacts for each outcome on revenue. One positive component, $\$_{soft}$, represents the contribution from Merrill's partial ownership of Bloomberg. A second component, $\$_{margin}$, represents the change in trading profits associated with more efficient and more competitive markets; this is expected to be negative, but if trading volumes are increased substantially this may actually be positive. A third component, $\$_{comp}$, represents the loss in trading income due to the increase in competitors' skills and the loss of Merrill's traders' advantage when Bloomberg is more widely available.

Thus, determining the NPV requires at least fourteen estimates: four probabilities, four estimates of $\$_{soft}$, and three estimates of $\$_{margin}$ and $\$_{comp}$. It is virtually impossible to get an accurate prediction for any of these numbers. Moreover, the final overall value computed for the decision may be strongly affected by a small change in probabilities. It is not surprising, therefore, that the most senior management at Merrill Lynch was unable to agree, for over a year, on a course of action.

Alternative Analysis: *Paradoxically, the analysis can be substantially simplified by increasing the complexity of the tree. This is illustrated in a variant of the decision tree shown in Figure 2.*

Note that with the tree structured as in Figure 2, Merrill's preferred course of action is now clear. If the systems will have only limited impact on the market, they should be sold and Merrill should accept its share of the limited additional profit that Bloomberg earns. Even if the systems have significant market impact, however potentially damaging they are to Merrill's trading profits, the firm should still allow Bloomberg to sell them. Compare the top three branches in Figure 2 with the following four. We can safely assume that p0 equals zero.[7] Now it becomes clear that the two top subtrees, in which Merrill Lynch allows Bloomberg to sell more widely and in which Merrill-Lynch does not, respectively, have identical structures. The probabilities associated with different marketplace responses are the same. The potential for negative impacts on Merrill's trading operations, $\$_{margin}$ and $\$_{comp}$, are also the same. The only difference is the firm's potential to earn significant profits from its investment in Bloomberg if Bloomberg is allowed to sell more aggressively. If Bloomberg sells to Merrill's competitors, Merrill receives its share of these profits. If it does not, then a competitor will eventually earn comparable profits instead. This is a very major difference indeed! Clearly, even in the case where Bloomberg has the potential to affect the market, Merrill prefers to receive some offsetting profits from its investment, and should allow Bloomberg to sell.

Thus, by careful restructuring, we have transformed the problem from an intractable one, requiring a considerable amount of data that would be difficult or impossible to obtain, to an equivalent problem that can be solved by inspection with the information already at hand.

Key lessons: *Sometimes the decision can be made rationally and analytically, even when it cannot be made numerically. If the problem can be structured so that the ranking of various courses of action is insensitive to a wide range of assumptions, it may not be necessary to compute the expected return of each action.*

Two key lessons emerge from this analysis, which are general and readily applied to strategic systems investments. Merrill Lynch was able to avoid the following two traps, frequently encountered when considering strategic systems [11]:

1. The trap of the negative net present value
2. The trap of the vanishing status quo

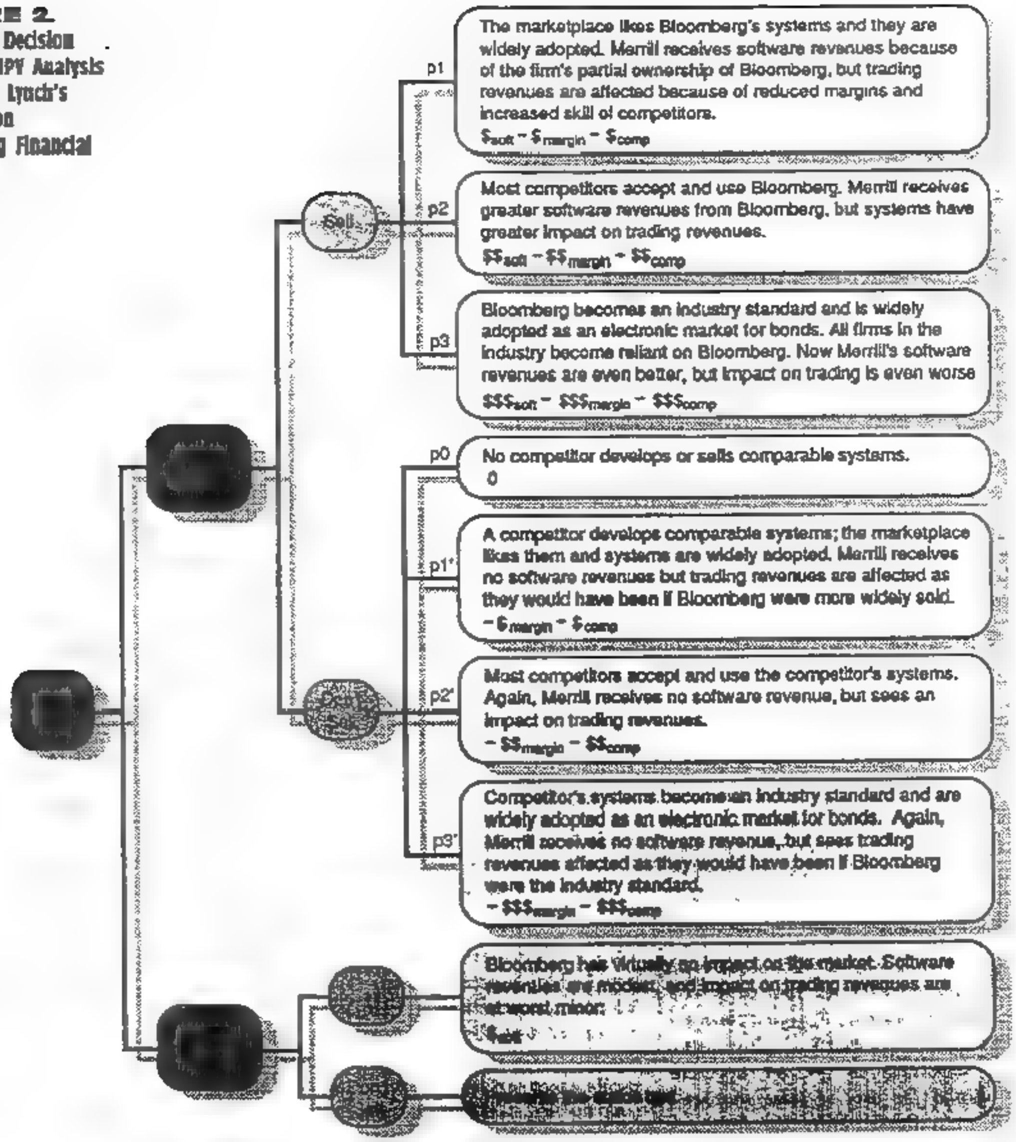
Usually, strategic systems projects involve a substantial additional investment, unlike the one considered here; it is then increasingly difficult to justify an investment that appears to have a negative net present value. As we have seen, it does not matter whether or not the decision's value is positive in absolute terms; it matters only that the value is superior to (less negative than) the alternatives. As in many strategic investments, the alternative to taking action may not be the continuation of the status quo. Frequently a competitor will choose to exploit an opportunity even if the firm does not; in this case, the alternative the firm then faces is likely to entail reduced margins, loss of market share, and a generally deteriorating competitive position. Barwise et al., describe these problems as "misstating the base case"; they argue that executives spend too little time considering the alternative to undertaking a strategic venture [1]. The principal contribution of restructuring the problem, as in Figure 2, was to structure the investment decision in the appropriate context, and thus to make the alternatives clear.

Note that this analysis was not easy. The absence of numerical estimates does not imply that no data were used; rather, given that quantitative analysis was not possible, alternatives had to be developed that exploited all available information.[8] Merrill Lynch's board agonized over this decision for more than a year, before the problem was structured in a

[7] Bloomberg's systems are extremely well done, but virtually all of the technology and all of the mathematical analyses are standard. There is no barrier that would permanently deter a competitor from developing equivalent systems. And if these systems are seen to yield significant trading advantage to Merrill Lynch we can certainly expect them to become generally available as other large houses develop comparable offerings.

[8] We challenge the idea that strategic systems need to be undertaken based on an act of faith [22] if sufficiently precise numerical estimates are not available for discounted cash-flow computations.

FIGURE 2.
Expanded Decision Tree for NPV Analysis Of Merrill Lynch's Decision on Bloomberg Financial Systems.



way that made a decision possible without precise estimates of individual competitive impacts. It is difficult to accept a recommendation that is not supported by detailed quantitative analysis. It is, however, in precisely this situation—with a great deal at risk, and no routine way of reaching an uncontested decision by traditional analyses—that senior executives act as decision makers and prove their value to the firm.

LESSON TWO

Sensitivity analysis is a widely used technique for dealing with uncertainty in decision problems. If it is not known precisely what value a parameter will assume, then the analysis is repeated with alternative values. The analyst may vary probabilities in a decision tree, or costs may be varied in a linear programming formulation, to determine how far parameters can be varied without altering the decision maker's selection of a preferred alternative.

It may be possible to compute

values for costs and benefits. Despite the uncertainty inherent in all estimates, sensitivity analysis may allow us to develop a fair degree of comfort in the conclusions.

McKesson Drug[9]

The problem: *McKesson Drug Company's Economost electronic order entry system is one of the best-known strategic information systems. It links McKesson to its customers: pharmacies and drugstores. In its most complete form Economost is both simple and powerful. It permits a drugstore employee to order by walking through the store with a bar-code reader and recorder, and waving a wand at any item that appears to be in short supply. Goods arrive the next day, in the store's order quantity, laid out in accordance with the store's floor plan and complete with the store's prices. Numerous management reports are available, some without additional charge. The information captured through Economost has been used to implement enormous efficiency improvements within McKesson, and a large portion of the benefits derived from these improvements have been passed along to McKesson's customers. The system is so attractive that over 99 percent of McKesson's order flow arrives electronically.*

Economost clearly has been strategic. In the first decade following its introduction, the number of drug wholesalers in the United States was reduced by 50 percent—from 180 to 90. Companies unwilling or unable to offer electronic order entry systems to their customers figured prominently among the early casualties. The benefits of systems like Economost are now so obvious that we take the basic system for granted, assuming that the decision to invest in Economost was easy, almost preordained.[10]

Actually, the decision was not easy. A small prototype electronic order entry system was attempted in 1973 in three sites, and response to it was mixed. McKesson's salespeople thought it was competing with them, and they hated it. Senior management realized that they were giving users of the system major price concessions, and were convinced it was a bad idea. Dave Malmberg, now the senior strategic planning officer for McKesson Corporation, was told "We know its a terrible idea. Build a model to prove it!"

A model was built and run under a wide range of assumptions, but the system still looked surprisingly attractive. Development of Economost was therefore begun.

Analysis: *Malmberg had to model the way the system would reduce McKesson's own costs, allowing them to reduce the prices they charged. He had to model the way reduced prices, and increased convenience, would increase customer order flow by getting customers to increase the share of their stock ordered from McKesson. He had to make assumptions about customers' willingness to cut their order frequency from once or twice a day to once or twice a week. There were no accurate estimates available for any of these. This seems to be an obvious opportunity for sensitivity analysis, which was of course performed. The target measure was return on investment [ROI], and the critical variables changed in the sensitivity analysis were pricing levels and sales effort.*

It was possible, however, for McKesson to arrange its investment in stages. Initially, a quick-and-dirty implementation was slapped together and installed in a few sites, at very limited cost. As the response to the system was received, the model was recalibrated, fit to the data, and rerun. Thus it was possible to reduce risk early, before significant software investment was made.

Key lessons: *Where there is uncertainty, but the possibility of quantifying some of the critical variables exists, financial analysis can be quite valuable. The sensitivity analysis that McKesson performed was essential in allowing them to reach their decision.*

The timing both of the investment, and the reduction of uncertainty, can be critical. Here, McKesson was able to obtain information, refine its model, and rework the numbers before incurring full development costs. And had the initial response been very different from the predictions, the firm would have been able to stop the project with very little lost investment.

Post script: *Economost was clearly a very good thing for McKesson, and failure to implement it would have been extremely dangerous. Still, it is interesting that a system that we now believe was a strategic necessity—instrumental in saving the drug wholesale business from pressures created by chain stores—was justified on such prosaic grounds. Impact on the industry was never considered. Competitor response also was not considered.*

LESSON THREE

It is Necessary to Balance Many Forms of Risk

There are many forms of risk, requiring many different approaches to risk management.

First Boston[11]

The problem: *When Gene Bedell, vice president, Information Services, came to First Boston after about a dozen years away from the securities industry, he was astounded. The environment in securities trading had changed much more rapidly than the installed systems architecture. Most transactions had required accounting in only a single currency; now transactions could require as many as four currencies. Derivative products for hedging and new trading strategies*

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[9] Material for this section comes from "McKesson Drug Company: A Case Study of Economost, A Strategic Use of Information Systems," [6] and from phone conversations with Dave Malmberg of McKesson Corp.

[10] McKesson's Economost has become almost an icon in the literature of strategic information systems. It has frequently and incorrectly been described as an example of competitive advantage, but the decision process leading to its adoption is seldom described in published work. In consequence, this has led to the mistaken idea that the decision was somehow easy, requiring little formal analysis.

[11] Material for this section comes from public sources [12,21,23] and from phone conversations and brief discussions with Gene Bedell in New York.

were increasingly important. The firm now traded entirely new financial instruments. Markets were global to an unprecedented degree. Regulatory climates were changing in the United States and abroad. Systems were increasingly important: in supporting complex trading strategies in real-time, in helping management assess and control trading risks, in selling effectively to increasingly sophisticated institutional investors, and in settling the large volume of trade. Yet the existing systems were surprisingly familiar, which of course meant they were surprisingly outdated. Like most major Wall Street houses in the 1980s, First Boston was forced to contemplate replacing all of its systems.

Any new architecture would have to support the following.

- Responsiveness to change: Rapid support for new products, and for regulatory changes, would have to be provided.
- Ability to exploit new technologies, so competitors who started later would not end up with a competitive advantage: As Bedell noted, "we could not risk being locked into any one technology in an era of rapidly changing technologies."
- Increased data-processing productivity and quality.
- Flexible, fast, easy-to-use workstations for everyone who used computers, with full graphics capability.
- A fail-safe architecture was required, with the possibility of taking the central system down without an impact on traders. This is difficult in a global, 24-hour environment, where New York's midnight is the middle of Tokyo's trading day!

From the start, the resulting architecture was based upon two guiding principles:

1) Seamless cooperative processing: Jobs could be initiated on a workstation, with its attractive interface and low cost. As these jobs had increasingly complex requirements, they could continue to run on any machine, including remote mainframes for database processing, without a request from the user, and even without the user's knowledge.
2) Advanced programming tools: Computer-Aided Software Engineering (CASE) and Object-Oriented Programming Systems (OOPS) could dramatically increase programmer productivity. Unfortunately, when the project was started, these tools were in early, conceptual stages of development. No tools existed to support cooperative processing across equipment from different vendors.

Bedell explains:

> Even before we had any clue on how to implement, we knew that these would be characteristics of the architecture. We started with the business needs and came up with the solution that would best meet those needs. Unfortunately, there was no way to implement this solution with the tools available at the time!

The initial architecture employed the following technology:

- Trader workstations were built on powerful personal computers.
- These were driven by fail-safe mini computers called Stratuses, located on each site; in addition to supporting the workstations, the Stratuses recorded all local transactions when links to mainframe database machines were unavailable.
- The Stratuses linked to central IBM 3090 mainframes for database processing, and for archiving and maintenance of historical data.

Discussion: The real decision was between conventional technology and implementation using new technology—CASE, OOPS, and cooperative processing. Bedell notes a major complication for the firm's analysis:

> The new technology was emerging as concepts, but there were no products available for building the systems needed for day-to-day operation of a business.

The project would require a five-year development effort. Bedell describes his two alternatives as follows:

1) We knew that if we used conventional technology, even if we were successful, we would finish with a brand-new obsolete system.
2) Instead, we could attempt to develop the tools we needed. We would run a very high risk of failure in developing the tools, but the possibility would exist for considerable competitive benefit to the firm.

Clearly, even if both development efforts had the same expected cost, they had very different cost distributions and very different risk profiles. With conventional architecture and conventional development methodologies, a statement of requirements would be developed and a system would be built to meet this fixed, unchanging specification. Unfortunately, the actual needs would certainly have changed during development, resulting in a system that was already drastically in need of overhaul immediately after completion. The CASE development effort could be divided into a fixed sunk cost, an investment made to gain a development capability, and a variable cost, the investment needed to develop applications of benefit to the firm. Since programmers could be far more productive with CASE tools available, it would be possible to modify or augment the statement of requirements, and to develop additional systems capability rapidly as changing requirements dictated. Given the anticipated improvements in productivity, and the need to respond rapidly to changing requirements in the industry, if it could be safely completed, the second alternative would be much more attractive.

The development of CASE tools could have been justified solely on the basis of cost savings resulting from increased productivity of systems personnel. This justification was rejected by the firm's most senior executives, who chose instead to emphasize the flexible response to changing needs that such productivity tools can provide.

How can such a decision be made?

Analysis: There are many components of risk. While there are considerable associated risks involved in letting a securities firm develop CASE tools beyond those that had been attempted by any commercial software vendor, there are also risks in developing inflexible systems in a rapidly changing industry.

We identify the following components of

risk, all of which must be managed and traded off against each other:

- Financial risk—*The firm cannot afford it. The financial exposure is unacceptable, or costs are not in line with projected benefits.*
- Technical risk—*It cannot be done. The necessary supporting technology is not available.*
- Project risk—*The firm cannot do it. The scale of the undertaking, or its technical complexity, or its fit with the skills and expertise of the development group, preclude successful completion of the project.*
- Functionality risk—*When the project is completed, it is unsuccessful: it is not what the user wants, or the environment has changed so dramatically during the time of development that the system is no longer functionally appropriate.*
- Systemic risk—*You just cannot win! The system is so successful, and it so dramatically alters the environment, that all assumptions about costs and benefits are rendered obsolete. This can be due to response from competitors threatened or harmed by the innovation, from customers or users within the organization, or in extreme cases, unfavorable regulatory changes made in response to the project's success.*

While Bedell believed that the project risk *obviously was considerable for First Boston's development of distributed multivendor CASE tools, he believed that this component of risk was also quite high for any massive conversion effort. The critical factor was* functionality risk: *in a rapidly changing global industry the programmer productivity and the resulting flexibility of the implemented systems, made possible by the CASE development environment, were the compelling reasons to choose the more technically advanced alternative.*

Key lesson: *Again, the decision appears to have been made rationally but not numerically. Payback period, return on investment, detailed sensitivity analyses were not factors. Real, carefully considered issues of risk management drove the decision. In particular, First Boston chose to accept considerably greater technical and project risk, in order to reduce functionality risk. That is, they accepted the possibility that they could not develop the tools they were attempting to create, knowing that if they were successful these tools would enable them to create and modify systems to meet uncertain and evolving needs. The alternative would have been the possibility of using traditional tools to develop less flexible systems that met only needs known at the time the project was begun, resulting in the possibility of a successfully completed project that would be certain to be inadequate to meet future needs.*

Post script: *The CASE development efforts were successful. First Boston estimates that they have received 100-fold (that is, close to 10,000 percent) increases in application programmer productivity! And they are now selling their CASE tools.*

LESSON FOUR

Actively Manage The Risk

Even when managers are confident that they have made the correct decision to proceed with a project, it is still necessary to manage risk. Identification of the various components of risk is the essential first step toward actively structuring and managing the risk of any large project.

Bell Canada[12]

The problem: *Bell Canada's current information systems evolved without a coherent plan or integrating architecture. Many of the programs are a dozen years old or more, and the overall system is inadequate to meet the challenges brought about by the changing marketplace, technological evolution, and changes in the Canadian telecommunications industry. Changes to billing can only be made slowly, and revenue and cost accounting can barely be done at all. Many programs are incompatible, requiring the rekeying of data to integrate them. The company has the technical capability to develop future telecommunications products, but it may not be possible to market them intelligently or bill for them efficiently. Examples include 800-service billing, and billing for virtually all ISDN*[13] *product offerings.*

Bell Canada will need to compete. It will need to increase its market. It will need to market effectively. As Robin Hamilton Harding, vice president and comptroller, noted:

> *How can you cut a dollar of expenses if you don't know whether it generates one dollar of revenue or two?*

How can you sell? How can you manage without knowing what is being sold? Marketers need to know what their deals mean.

Moreover, the structure of Canadian markets will change over the rest of this century. As Uwe Natho, assistant vice-president, noted:

> *Currently 25 percent of our revenue comes from deregulated lines of business. It will reach 75 percent.*

Therefore, under the comptroller's leadership, Bell Canada initiated the Corporate Revenue Information Systems Project (CRISP), the first and most crucial phase in developing a new information systems architecture. CRISP would involve a phased conversion of all of the programs and files associated with billing information, in excess of 5,000 program modules, 2.7 million lines of code, and 270 files; these would be replaced with approximately 25 program modules, and a shared relational database. Although the cost of the project would be considerable, Bell expected commensurate benefits to do the following:

- *greatly increase information available to marketing, including analyses by customer account and product line,*

[12]Material for this section comes from "The Bell Canada CRISP Project: A Case Study of Migration of Information Systems Infrastructure for Strategic Positioning" [8].

[13]Integrated Services Digital Networks (ISDN), is a family of standards that make possible a wide variety of new and sophisticated business telecommunications services.

When the environmental changes are rapid enough to be considered discontinuities, rapid and flexible organizational response becomes essential.

- *greatly increase flexibility in the reports, currently known and still unanticipated, that could be developed from the relational data,*
- *bring new applications on-line rapidly and cost effectively to support marketing needs,*
- *be more responsive to the needs of customers, especially commercial accounts,*
- *market information service products.*

Analysis: *Although the project was studied extensively, no formal financial analysis was used to justify proceeding. The system was described as a strategic necessity, and presented without detailed financial analysis, decision trees, payback period, or sensitivity analysis. Robin Hamilton Harding, the lead program officer and a senior officer with considerable credibility within Bell Canada, argued convincingly that the system's conversion would be essential for Bell to remain competitive.*

He thinks there are several reasons for the executive officers' approval in the absence of demonstrated hard economic benefits. Chief among these is the general support built into the organization prior to submitting specific project proposals. All affected business units were intimately involved with the development of the plan. Moreover, he consciously sought support for the project prior to embarking on the approval process. His staff had already developed considerable support among operational personnel in affected functional areas like marketing. This was intended to reduce the project's political risk.

In addition, although Bell believed that it was essential to proceed with the project, management took prudent steps to identify and manage various components of risk. They divided the large $30-to-$40 million project into several modules, none of which cost over $2 million, thereby reducing the exposure, the level of complexity, and magnitude of organizational change that must be managed at any one time. This greatly reduced the financial risk of the undertaking. The ordering of modules has been arranged by economic, organizational, and practical considerations. The most visible tasks, those that produce tangible outputs of immediate value, are to be completed first. Success on these tasks will establish an experience base and a visible track record that should facilitate the approval and implementation of other tasks; this also will reduce the project's political risk.

It was marketing personnel who were intended to be the major users of the new information, and thus would need to be instrumental in defining and improving the statement of system requirements. Therefore, the comptroller's staff cooperated closely with the marketing department. This was intended to reduce the risk of the system failing to meet the future needs of its users; that is, these actions were taken to reduce functionality risk.

Although it is expected that the new system infrastructure will considerably reduce the cost of developing new software, this was not used as a justification for the project. Since the flexibility in obtaining marketing information and the timeliness in supporting the marketing of new products in a changing environment was seen as crucial to the future success of the company, no attempt was made to quantify the benefits of this flexibility.

Key lesson: *Strategic necessity is a compelling argument. When the environmental changes are rapid enough to be considered discontinuities, rapid and flexible organizational response becomes essential. Even when the value of an architectural investment to obtain this flexibility is difficult to express quantitatively, it can be explained as buying an option that may be necessary to ensure the firm's survival. The credibility of the person raising the argument is critical. The need for such a champion is especially important for large projects, in which a feeling of ownership within the user organization will be crucial. And, even for strategic necessities, risks must be managed.*

LESSON FIVE

[illegible]

A firm is unlikely to retain a long-term advantage, without some fundamental defense other than its technology. Our own experience, based on studies of numerous companies and industries, is that technology is readily acquired, systems are readily copied, and competitive advantage from systems is likely to be sustained only if it leverages key nontechnological assets not readily available to competitors [7].

BZW TRADE[14]

The problem: *Barclays de Zoete Wedd (BZW) is the largest market maker in the United Kingdom, making market in over 1800 equities.*[15] *Additionally, its market makers have one of the largest*

[14]Material for this section comes from our own study [9] as well as public sources [2,14,15,26,27,28], and extensive discussions with Nic Stuchfield, Peter Holloway, and Ian Macdonald of BZW's equities market making operations (London, August, 1989 and March, 1990).

shares of retail orders. Retail business traditionally has not been very important in London. While it is widely regarded as unprofitable, there are opportunities to improve the competitive situation with automation. In particular, BZW was evaluating customer-order entry systems, which could greatly reduce execution costs for both BZW and its customers, and increase the firm's market share as well. If a system to automate broker order entry should actually provide benefit, it would be necessary to defend against competitors' responses.

London's International Stock Exchange now has no trading floor. Market makers use the Stock Exchange Automatic Quotation (SEAQ) system to post their bids and offers, and the size at which they are prepared to deal. These prices are widely disseminated in real-time, to other market makers, to agency brokers, and to major institutional investors, in London, throughout the United Kingdom and abroad. All trades that do not exceed the posted size must be executed within the touch, *the best bid and offer. Firms have an incentive to post the best price—to be on the touch—to attract order flow; however, customers or their brokers are free to call around, and any market maker is permitted to deal if it is willing to match or beat the current best SEAQ price.*

BZW launched TRADE, an automatic order-entry system for retail brokerage, in the summer of 1988, seizing an opportunity created by repeated delays in the Stock Exchange's own automatic order-entry system, SAEF. TRADE uses the best prices prevailing on the London Stock Exchange, and automatically routes orders to BZW's market makers at these prices, even if the prices that BZW was offering on the Exchange at the time were inferior. Brokers are assured execution at the best available price, and automation reduces their back office expenses; the combination was expected to increase BZW's market share. And this same automation was expected to reduce BZW's own costs sufficiently to make retail brokerage orders attractive to the firm.

Discussion: *Many within the firm felt that retail orders were inherently unprofitable, and that nothing should be invested to increase retail business. Senior equities personnel at the time, Nic Stuchfield, director of United Kingdom Equities, Peter Holloway, managing director of Equity Trading, and Ian Macdonald, head trader U.K. Equities, however, felt that if costs were reduced sufficiently the business could be profitable.*

Moreover, Nic and Peter believed that any advantage gained through a system like TRADE could be defended: BZW makes market in the largest number of securities in Britain. A competitor launching an equivalent system could not offer customers the same range of coverage, and hence the same convenience; equities for which the competitor did not make market could not be ordered through their system. BZW's market makers enjoy one of the largest shares of retail orders, so most competitors could not capture the same scale economies available to BZW. BZW has long-established relationships with most of the brokers with whom they work. Thus, a competitor would have to counter both these working relationships and the advantages offered by TRADE.

Analysis: *Making the investment decision to proceed with the development and installation of TRADE involved the following:*

- *Estimating development costs—this seems right on target and was relatively easy.*
- *Estimating reduction in their own trading costs—They believe that their original estimates, that execution costs to BZW could be reduced from £7 to £2, were correct. It was, however, very difficult to make this argument convincing.*
- *Estimating increase in market share—this was very difficult. They had experience with their Retail Order Room, a manual version of TRADE, as an initial estimate. And they ran sensitivity analyses, varying estimates across a spectrum.*

Given the uncertainty in their estimates, it was necessary to perform sensitivity analysis. Analyses were done varying reductions in their own trading costs and increases in market share. Under a wide range of assumptions, TRADE appeared justified, and the decision was made to proceed.

BZW attempted to consider the response from competitors. BZW accurately foresaw the difficulty of other market makers attempting to launch competitive systems. Kleinwort Benson's BEST was launched before TRADE. Although competitors' systems are no doubt being developed, to date no other market maker has launched a competing system in response to TRADE.

Key lessons: *Sometimes we can do an NPV analysis, or a payback period analysis, even for strategic investments, and capture uncertainty through sensitivity analysis.*

If a venture is attractive to the firm, it may well be attractive to competitors. Thus advantage, if it is to be sustained, must be based on exploiting certain key assets—in this case, scale of retail operations and scope of market-making capability—not readily available to these competitors.

Post script: *Early evidence indicates that TRADE has been successful. Some brokers have doubled the share of the orders they bring to BZW from 20 percent to 40 percent, and have placed an artificial cap of 50 percent to avoid excessive dependence on any single firm.*

Moreover, no competitor has gone through with plans to launch a system to compete with TRADE. Despite the fact that the technology could readily be duplicated, the fundamental advantages enjoyed by BZW appear to represent a significant barrier to competitors.

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[15]A *market maker* in London trades for the firm's own account, buying from or selling to brokers who have customer orders. While the broker earns money on commissions, generally a percentage of the value of the trade, the market maker earns much of his profit from the *spread*, the difference between the *bid*, or buying price, and the *ask*, or selling price, of the security.

While BZW makes market in over United Kingdom 1800 securities, and Warburg Securities does so in almost 1800, no other firm comes close in the United Kingdom market. Smith New Court is next with about 800, and international giants like Merrill Lynch, with under 120, and Nomura, with about 20, are inconsequential in United Kingdom equities.

LESSON SIX

Pursue Cooperative Advantage

We have found, in studies of numerous industries in the United States and abroad, that sustainable competitive advantage is quite rare and quite difficult to achieve. The sort of unambiguous resource advantage enjoyed by BZW occurs only rarely, thus, strategic ventures for competitive advantage may not always produce the desired results, even if systems development efforts are executed perfectly. And, given the high cost of developing software ventures and the ease of ratcheting up the volumes that they can process, cooperative ventures should be seriously considered. When competitive advantage appears unlikely, or when a major competitor's size places a firm at a competitive disadvantage, cooperation may offer significantly reduced costs.

Philadelphia National Bank MAC[16]

The problem: *When Girard Bank launched George, its proprietary ATM network for Girard's retail banking customers, it was clear that all other retail banks and savings and loans in Philadelphia would need to respond. Girard was a major Philadelphia bank and had the largest share of retail banking. Banks that could not, for whatever reason, match Girard's George faced the prospect of inevitable, serious decline in their share of Philadelphia area retail banking.*

Unfortunately for PNB, ATM networks exhibit significant economies of scale. The cost of central-site hardware and software to drive the network is largely independent of transaction volumes and the number of installed ATMs; a small bank, with very few ATMs, will thus have much higher average costs than a larger bank. Additionally, the value to customers increases rapidly with the number of ATMs installed. Customers expect ATMs convenient to where they bank, where they work, where they live, and where they shop. A large bank, with a large number of retail customers, can afford to put in enough ATMs; a small bank, with fewer customers, will once again be at a significant disadvantage.

Philadelphia National Bank found itself in an untenable position. It believed it was necessary to respond to George. And, given the scale of its retail banking operations and the anticipated impact on its bottom line, it was unacceptable to bank management to pursue a meaningful proprietary response on its own.

Officers at PNB realized that they could not be alone: they could not be the only retail bank in Philadelphia that was not the largest.

Consequently they launched MAC, a shared ATM network available to any and all banks.

MAC could have been launched as a joint venture, owned and operated by many participants. Instead, MAC was wholely owned by PNB, with other banks paying fees for transactions that MAC processed.

Analysis: *Participation of additional banks offered PNB an opportunity to achieve necessary scale. Each bank that joined MAC would increase the number of machines available to the cardholders of all participating banks and improve the regional coverage of machines; this would make the network coverage meaningful to the banks' customers. As the number of banks increased, and transaction volumes rose, MAC's average costs would decrease to the point that MAC would become profitable for PNB. MAC would also reduce operating costs for member banks.*

PNB chose to launch MAC as a single-owner shared ATM network, for two reasons. The first was ease of coordination and maintenance of bottom-line financial discipline. The second reason was the perceived up-side; their potential for future profits from MAC appeared greater with PNB as the owner. PNB launched MAC as a fully generic product, not branded or tied to PNB in any way. Moreover, it was clear to member banks that PNB did not receive preferential treatment nor enjoy any proprietary advantage from its operation of MAC. PNB's strategy for MAC required participation from other Philadelphia-area banks to achieve scale of operations and widespread deployment of ATMs. Only with PNB's foregoing competitive advantage in retail banking through its MAC connection would it receive the trust and cooperation from other banks needed to launch MAC and make it successful.

MAC can clearly be viewed as successful. After a recent sequence of acquisitions, including CashStream, the successor to Girard's George, MAC is now the only surviving ATM network in Pennsylvania. PNB is earning profits on MAC, member banks do not feel these profits are excessive, and at present the arrangement appears stable.

Key Lessons: *Through cooperation with competing banks, PNB not only countered a common threat from Girard, they ultimately owned the ATM network business in the state of Pennsylvania. Cooperation—working with or selling to competitors—can be an effective way to develop required scale or acquire other necessary resources. Cooperative arrangements are becoming increasingly frequent and increasingly important. Paradoxically, sometimes the best way to assure competitive success is to launch a cooperative venture.*[17]

LESSON SEVEN

Do Not Forget the Downside

When considering a strategic investment in information technology, the uncertainty associated with success may delay the undertaking. Alternatively, the attractive profit stream associated with current op-

[16]Material for this section is drawn from "Philadelphia National Bank's Strategic Venture in Shared ATM Networks" [14].

[17]This is explored in more depth in an earlier article [5].

erations may appear to offer a compelling reason to forgo strategic change. As noted in the discussion of Merrill Lynch's decision concerning Bloomberg, however, some investments should be made to limit the possibility of future losses, rather than to obtain long-term additional value.

The trap of the *vanishing status quo* is especially dangerous when used to justify avoiding investments needed to deal with radical environmental shifts. Most United States airlines, profitable under the regulatory regime of the mid 1970s, chose neither to develop computerized travel agent reservation systems nor to share the investment with a major player already developing such a system. These reservation systems did not appear to be necessary. Within a decade—which should be within the foreseeable future for executives—these systems became crucial. Some carriers are now paying hundreds of millions of dollars to acquire partial ownership. Others are paying hundreds of millions of dollars in booking fees to their competitors!

Sometimes an investment, not essential at present, should be undertaken to preserve the future courses of action open to the firm. Ned Bowman and Bill Hamilton refer to such opportunities as *strategic options* [20]. Once the investment has been made, it may permit the exploitation of opportunities that arise at a later time. Sometimes investing in a strategic system can be viewed as buying an option on the future survival of the firm. For example, some financial services companies enjoy limited competition in their markets, due to continuing regulation. These firms can expect their protected niche to be eroded in the future; at some later time, they will find themselves competing against CitiBank. Thus, while their information systems infrastructure may be adequate for their current competition, it is almost certainly inadequate for future needs. Infrastructure investments may be impossible to justify in terms of delivering current application needs; these same investments may be viewed as essential if they are seen as positioning the firm for the future, allowing it to respond rapidly to emerging competitive threats. Similarly, as noted above, Bell Canada's decision to embark on CRISP can be viewed as buying an option on the future of the company.

Finding and evaluating strategic opportunities to use information technology, and then justifying the decision to make the necessary investment all require a set of skills different from those historically required of IS executives.

Conclusions

We believe that information technology can be strategic to many firms. In fact information technology is now likely to be essential to the delivery of any new strategic effort—in manufacturing, distribution, sales, or service.

The strategic impact of information systems poses a new problem for MIS management. Finding and evaluating strategic opportunities to use information technology, and then justifying the decision to make the necessary investment all require a set of skills different from those historically required of IS executives. *A priori*, the decision—to proceed with or to cancel a strategic program—is often difficult; only after the fact may the results appear obvious.

Part of the problem comes from viewing even strategic opportunities to invest in technology as projects, to be judged on their expected value, and included or excluded from the company's portfolio on capital budgeting criteria. Sometimes these opportunities may be too critical to be treated in this way: the future benefits are too wide-ranging to be estimated with any accuracy; or the implications of failure to invest in the technology may involve permanent loss of competitive strength within the industry. While these problems are not unique to information technology investments, they are being faced by IS executives for the first time. Additionally, some information systems ventures can, if successful, so radically alter the operating environment of the firm that precise predictions for quantitative analysis are impossible to obtain, making these programs especially difficult to evaluate.

Strategic systems can have enormous impact on a firm and its entire industry, and can involve commensurate risk. Therefore, when beginning a strategic program, it is essential to ask the following questions:

- What are the benefits, both tangible and intangible, of the proposed strategic program? How might changes in the firm's future operating environment, either externally imposed or actually caused by the strategic program, alter estimates of these benefits?
- What are the costs of undertaking the program, and what are the costs of potentially being frozen out of future opportunities by failing to undertake the program?
- What are the risks of proceeding with the program, and how can they be managed?
- What is the expected competitive impact? What proprietary resource advantage does it exploit, allowing advantage to be sustained and protected?
- If there is no resource advantage or barrier to competitors' duplication, would it make more sense

to develop cooperatively? Conversely, if there are resources that the firm lacks, might it make sense to develop with strategic partners, to counter these resource problems?

Evaluation of strategic investments in information technology, like all strategic decisions made by senior managers, will never be routine procedures. With the application of the guidelines presented above, however, these crucial decisions can be improved.

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WHARTON REPROGRAPHICS

Microsoft Corporation: Office Business Unit

On March 30, 1990, Jeff Raikes, general manager of the Office Business Unit (OBU), glanced out the window one last time as the rain began to fall softly on the Douglas Firs at Microsoft's beautifully landscaped Seattle campus. The peacefulness of the setting contrasted sharply with the turmoil of the software development projects in the applications division.

One recent project, Opus, had been particularly difficult. Opus, Microsoft's code name for the Word for Windows[1] word processor development, had finally been shipped on November 30, 1989 after over five years of development. With the completion of the Opus project, two major issues arose: (1) what the follow-on project should be; and (2) how the development process's speed and effectiveness could be improved.

Although the schedule slipped significantly from the originally projected ship date (see **Exhibit 1**), Word for Windows (known internally as WinWord) received significant critical acclaim. It was Microsoft's first word processor to be rated higher than archrival WordPerfect by the influential computer journal, *InfoWorld*. Sales exceeded Microsoft's projections.

Microsoft History

Microsoft Corporation had its roots in a company called Traf-O-Data that Bill Gates and Paul Allen founded in 1973 when Gates was only 16 years old. Gates had started programming when he was in junior high school and, by the time he was in ninth grade, local Seattle companies were employing him as a programmer after school hours. Gates and Allen formed Traf-O-Data in an unsuccessful effort to market software that generated summary traffic flow statistics derived

[1]Windows was an operating system written by Microsoft for the IBM PC which provided an easy-to-use graphic user interface, allowed convenient data sharing and switching between different application programs, and enabled programmers to write larger applications than with DOS.

Professor Marco Iansiti prepared this case as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

from a rubber tube strung across a road. The software ran on an Intel 8008, the first 8-bit microprocessor[2] ever developed.

In 1974 Gates was graduated from high school and began attending Harvard College. He did not stay there long, however. Early in his college career, he wrote a BASIC interpreter[3] for the first commercial microcomputer, the Altair, developed by a startup called MITS. The entire development required only four weeks even though Gates had to write the program without even seeing the Altair, working only from an emulator that Allen had developed. Soon after the program was completed, Gates and Allen reached an agreement with MITS to sell Gates's version of BASIC and Gates dropped out of Harvard to work full time with their company, which they renamed Microsoft. The Altair computer took off and Gates's implementation of BASIC became a standard. Over the next several years, Microsoft developed programs for a series of computers, including the Apple II and the Osborne portable computer.

Microsoft's big break came in 1980, when IBM chose it to develop the operating system for its personal computer. The result was MS-DOS (Microsoft Disk Operating System), a copy of which accompanied virtually every IBM and IBM-compatible personal computer (PC) sold.[4] IBM also worked with Microsoft to develop a BASIC and several other computer languages. DOS and the languages gave Microsoft a large, solid customer base on which to grow. And grow it did. From 1980 to 1989, Microsoft annual sales increased from less than $1 million to over $800 million (see **Exhibit 2**). The company's employment grew from 45 people to over 4,000. In 1988, Microsoft's sales passed Lotus Development Corporation's (the maker of the 1-2-3 spreadsheet), making Microsoft the largest personal computer software company in the world.

Profits and stock price increased as well. In 1989, Microsoft's return on sales was over 15%—the highest of any major software company Microsoft also had an aggressive employee stock ownership plan, and it was estimated that over 200 Microsoft employees had been made millionaires by increases in Microsoft's stock value. Gates, himself, had become the microcomputer industry's first billionaire.

By 1989, the approximate size of the personal computer software industry was $9 billion. While sales growth in the industry had been spectacular in the early 1980s, growth slowed somewhat in subsequent years, from a 30% yearly growth rate in 1987, to a 15% rate in 1989. Competition intensified, as the number of products on the market increased. Moreover the products themselves were becoming increasingly complex, incorporating more advanced features, and integrating with a greater variety of hardware and operating system environments.

During the 1980s, Gates almost singlehandedly determined Microsoft's technical direction (Allen, his cofounder left Microsoft in 1983 for medical reasons). After seeing results of research involving a graphical user interface (GUI) performed at Xerox's Palo Alto Research Center (PARC), Gates became convinced that this type of interface would become the standard in the

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[2]A microprocessor was a single chip that contained all the essential circuitry for a computer's central processing unit (CPU). The 8008 chip was a predecessor of the Intel 8088 that was used in the IBM PC.

[3]An interpreter allowed a user to program the computer using simple English-like commands.

[4]In this case, PC refers to any IBM or IBM-compatible personal computer. Microcomputer is the generic term for any single-user computer.

industry.[5] For this reason, Microsoft started to develop a similar interface for the PC. The resulting program, Windows, added an additional layer of software between DOS and applications programs. Windows provided a set of utilities that allowed applications programs to work together in a user-friendly graphical environment. First released in 1985, Windows was slow to catch on. Microsoft continued to improve the program incrementally, and by March 1990, Windows had gained significant momentum with approximately 2.5 million of the 40 million PCs installed, having Windows.

Although the languages (compilers and interpreters) and operating systems for PCs formed the core of its business, Microsoft soon began to move into the applications software market. In the 1980's, software could roughly be divided into three categories. Operating systems were the programs (like MS-DOS) that controlled the low-level operations of the computer (such as reading data from disks). Compilers and interpreters translated computer languages that were made up of English-like commands into machine language (series of 1's and 0's) that the computer could understand. Applications were the programs that end users typically ran (such as spreadsheets and word processors) to do specific tasks.

In 1983, Microsoft became the first software company to develop software for the Macintosh, and, by 1990, Microsoft was the major applications developer for it. Microsoft Excel was the dominant spreadsheet in the Macintosh market (with approximately a 90% market share) and Microsoft Word for the Macintosh was its dominant word processor (with 65% unit share and 80% revenue share).

Microsoft was not able to achieve the same market dominance in PC applications as it had in its other markets. Both its high-end word processing software (PC Word) and spreadsheet (PC Excel) were the second most popular products in their respective markets. Although these were successful products, they had yet to overcome their entrenched rivals (WordPerfect and Lotus 1-2-3). On the other hand, Microsoft was the only software company to compete successfully in all three segments, and was one of the few companies to have more than one market-leading application. By 1990, applications products accounted for over half of Microsoft's revenue (see **Exhibit 3** for a list of Microsoft's major products and their market shares in 1990).

Microsoft's products were not all a result of internal development. Gates actively sought out small companies with advanced technology. In fact, MS-DOS was an extension of SCP-DOS, a product developed by Seattle Computer Products that Microsoft purchased and adapted to the IBM PC. Although adapting and extending a product developed outside Microsoft was quite common, Gates usually preferred to perform the development of strategic products in-house.

Microsoft Organization

In 1990, Microsoft was divided into two groups: applications and systems (languages and operating systems). The Applications Division was headed by Mike Maples, who reported directly to Jon Shirley, the president and COO. Under Maples, there were six groups: Applications Strategy and five business units. Four departments comprised Applications Strategy, which provided central resources to all the business units. The resources ranged from programming tools and common subroutines to a User Interface Laboratory where the process by which test subjects

[5]In 1984, Apple introduced the Macintosh which employed GUI concepts and was widely praised as being fun and easy to use.

learned and used software could be observed and recorded. Because these central resources were available on a voluntary basis, there was wide variability to the extent that the business units and even individual projects used them (see **Exhibit 4** for a partial organization chart).

All the business units were organized similarly, each specializing in a particular applications area. Jeff Raikes was the general manager of the Office Business Unit (OBU) which developed and marketed all of Microsoft's high-end word processors (PC Word, Mac Word, and Word for Windows). Under Raikes, the departments were organized by functional responsibility. Quality Assurance (also known as Testing) tested all the software for bugs and errors in the documentation. User Education wrote the documentation. Development, under Chris Mason, was responsible for developing the software. Product Marketing and Program Management also had separate departments. The other business units were responsible for different applications such as spreadsheets and databases.

The business unit organization had been instituted in August 1988 in order to help the Applications Division manage its growth. Prior to 1988, the entire division had been organized on a functional basis—so that there was only one department for each in the division as opposed to one for each business unit in the division. Raikes commented on the change: "At Microsoft, we have a process of on-going organizational change—it helps to maintain a small company feel and team focus."

Evolution of the Development Process

In Microsoft's early days, there were few colleges or universities that offered degrees in computer science and computers were relatively scarce. Finding programmers was difficult and, like Gates, most of the early Microsoft developers had little or no formal training in computers. Many had been trained in other fields (particularly in math and science), but had fallen in love with programming.

The development process in the early days was more informal and there was less emphasis on schedule methodology and software architecture. Perhaps because of their lack of formal training, most of these developers did not follow the highly structured software development methodologies created by the Department of Defense and large corporate MIS departments. They often developed software without a formal specification or design. In 1990, stories about legendary developers abounded:

> There was one guy who could type at 80 words a minute. That's pretty impressive, but what's really impressive was that he actually wrote code at that speed. He'd write a 10,000 line application in two days, then if it didn't work, he'd throw it out and start again from scratch. He'd go through this process two or three times, until he ended up with a working program. Not only did it take him less time to do this than if he had sat down and tried to think everything out in advance, but the program that resulted was better too. Because he had implemented the same program several times before, he knew how to avoid all the pitfalls so his code became very clean.

One of Microsoft's early developers described his own views about software design:

> I design user interfaces to please an audience of one. I write it for me. If I'm happy I know some cool people will like it. Designing user interfaces by committee does not work very well: they need to be coherent. As for schedules, I'm not interested in schedules; did anyone care when *War and Peace* came out?

Raikes described some of the problems of relying too much on such star performers:

> There are a lot of problems with relying on individual superstars: (1) they are in very short supply; (2) someone has to maintain and update the software they've written (which often doesn't interest them) and often other people have difficulty understanding their code; (3) sometimes they don't understand what the market wants; and finally if you try to put several of them on the same project you get real problems with design decision—"too many cooks spoil the broth."

During the early to mid-1980s, Microsoft was often criticized for writing software which was technically excellent but difficult to understand and hard to use. In an attempt to make Microsoft more responsive to the market, in the early 1980s Gates began to hire marketing specialists, both from other software firms and also directly from MBA programs. Many of the new arrivals were not technical experts, but their mission was to reorient Microsoft to focus on the customer.

To help bring a more coherent perspective, a program management function began to evolve. Jabe Blumenthal, a marketing assistant who became the first program manager, described the evolution of the function in more detail:

> In early 1984, we began to work on a spread sheet for the Mac. I got involved and became a sort of service organization for the development group. I helped document the specifications, do the manual reviews, and decide what bug fixes were important and what could be postponed to a later release. While I didn't make the design decisions, I made sure that they got made. The process worked out really well, so they decided to call it something and institutionalize it.

Raikes described the purpose of the program management function:

> Program Management was introduced to formalize design, coordinate product creation functions (development, testing, and user education), and perform support functions (such as manual reviews, and competitive product evaluation).

In 1990, several people shared leadership for the development of a new product: the **project lead** and the **technical lead** from the development group, the **program manager** from Program Management, the **product manager** from marketing, the **on-line lead** and **print-based lead** from User Education, and the **localization lead** from the international division. These people were supposed to work as a group, with no one person having total authority. The project lead was responsible for overseeing the product development effort including handing out programming task assignments, scheduling, and coordinating the development effort. The technical lead had final say in all technical decisions, code reviews, and programming standards. The product manager handled all the marketing issues such as competitive analysis, positioning, packaging, and advertising. The program manager's job was to integrate and coordinate the efforts of everyone involved in the project. Program managers were also directly responsible for the concept and specification of the product. The on-line and print-based leads handled the user education functions and the localization lead oversaw the customization of the program for various international markets.

A team of about a dozen developers was usually dedicated to each major development effort, and was responsible for writing the code. Microsoft managers were quite proud of the small size of their teams. Other major competitors would use much larger teams often including more than

one hundred programmers for major applications. Microsoft's cost per line of code developed was significantly lower than the industry average, which was about $125 in 1989.[6]

Despite the fact that he had a key role in the development of the system, Blumenthal felt that the process had many problems:

> The problem is that they did not copy a lot of what caused our effort on the Mac spreadsheet to be successful. We had a small group, I regarded myself as a service organization, and I was best friends with the developer. Now program management owns the product; they write the spec and throw it over the wall. The product managers don't know much about the realities of development, and the developers don't know the competition. The program managers have become a bottleneck—they make all the decisions, and the developers act as if they have no responsibility for the product.

Chris Mason, the development manager of the Office Business Unit (OBU), however, described a different interpretation of the development process:

> While Microsoft has become somewhat more formalized, the basic truth is that developers still have ultimate control of the process. If they want to check in a piece of code, there is no way we can stop them. There comes a time in every development project where the development manager says 'no new features shall be added,' but if the developer feels strongly, there is not much the manager can do. Microsoft has a deep underlying philosophy that people know what they are doing and will try to do the right thing.

Despite the changes in the development process, Bill Gates remained a constant factor, actively involved in every major development project. He attended design meetings periodically, reviewed design specifications and project schedules, and read many of the periodic status reports. Although many people at Microsoft had experienced his sometimes harsh critiques, there was universal respect for his technical expertise and ability to forecast where the computer industry was heading.

The Development of Word for Windows

Microsoft introduced its first high-end word processor for the PC, "PC Word", in late 1983. The product received only lukewarm reviews, and its sales were mediocre by Microsoft's standards. In September 1984 Gates, convinced that a key opportunity was being squandered, prompted the development of a new revolutionary word processor. The new product was going to run on the Windows operating system (at that time in development), and was going to exhibit some extremely innovative features to make Microsoft the leader in PC wordprocessing. Gates gave three people, John Hunt, Andrew Hermann, and Lee Arthurs, responsibility for the project which was code named Cashmere. Greg Slyngstad, who later became program manager for Cashmere, describes the start of the project:

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[6]Rules of thumb for programmer productivity in the industry averaged over a project typically ranged between 5 to 10 lines of code per day. These measures were considered very rough guidelines.

> Gates put three real hotshots on the project. Hunt, who had single-handedly written the first version of PC Word, became the project manager. Arthurs, who had a Ph.D. in psychology, was responsible for user interface and documentation. Hermann had been at Wang and was supposed to know the word processor business inside and out.

In giving the Cashmere team its assignment, Gates directed that they "develop the best word processor ever," and that they complete the project as soon as possible—preferably in less than a year. Thus, the project was scheduled to be completed by October 1985. Not much progress was made, however, in the first year of the Cashmere project. Hunt brought on a couple of software developers to prototype software and he, Hermann, and Arthurs wrote several papers suggesting the features to be included. Their original concept was to integrate a uniform user interface and data structures for multiple purposes at the lowest level. In other words, they planned to structure the program and data so that it integrated seamlessly into other types of applications such as spreadsheets and databases. Not only would the new product be able to interface with other applications, but it would include some of the same types of features that these applications included so that the distinction between product categories would blur. Some of the specific features to be included were electronic mail, document protection (so that other people would not accidentally destroy someone's documents), facilities to build mail lists, and primitive spreadsheet capabilities.

By the beginning of 1986, the scheduled ship date was still approximately a year away, and Gates began to put pressure on Hunt to get some visible results. Eventually the pressure got to be too much for Hunt and he left the project in July 1986.

When replacing Hunt, Gates decided to use the program manager concept which was being developed at the time. Three Microsoft veterans were brought in: Doug Kurtz, the PC Word development lead, took over the same role for Cashmere; Lars Dormitzer, a well regarded developer, assumed the technical lead role; and Slyngstad became the program manager. A new marketing manager, Jeff Sanderson, was also brought in. As a new team member recalled:

> We all thought that the project was much farther along. Although Hunt had written a bunch of papers describing features that he wanted, there was no comprehensive specification of what would be in the product. We ended up throwing everything that had been done out, and started from the code used in Word for the Macintosh. We were a year behind schedule from the first day we started.

At this point, the project was renamed Opus. A new team of developers was formed. Due to a shortage of experienced developers, the new team was almost entirely staffed with new hires. Very few of the developers had had experience with other Microsoft projects.

During the second half of 1986 and the first half of 1987, a lot of effort was spent writing a new specification for the product. As time passed, however, pressure built up on the team to show visible results. The schedule continued to slip into 1988, and the pressure increased to a disturbing level. Sean McDermott, who was a software development engineer (SDE) on Opus at the time, recalled this period:

> We were under a lot of schedule pressure. Some managers seemed to regard the schedule as a contract between them and the developers. Furthermore, when development came up with a new schedule, management questioned every estimate.

Upper management kept up the pressure. During one meeting in early March 1988, one manager indicated that he felt that the Opus team was the worst in Applications Development. Chris Mason, the OBU development manager, recalled the effects of the constant schedule pressure:

> Opus got into a mode that I call "Infinite Defects." When you put a lot of schedule pressure on developers, they tend to do the minimum amount of work necessary on a feature. When it works well enough to demonstrate, they consider it done and the feature is checked off on the schedule. The inevitable bugs months later are seen as unrelated. Even worse, by the time the bugs are discovered, the developers can't remember their code so it takes them a lot longer to fix. Furthermore, the schedule is thrown off because that feature was supposed to be finished. These problems aren't unique to Microsoft—every company in the industry faces them.

In April 1988, Dormitzer had to take a medical leave of absence. McDermott, who had less than two years of experience, was made technical lead. Although McDermott was relatively young and inexperienced for such a position, the job required a very detailed knowledge of the program, and no one with more experience had the required knowledge. McDermott was also an outstanding technical contributor. Two months later, Kurtz, who had tired of the continual pressure, took a leave of absence from Microsoft. Dormitzer, who had recovered somewhat, came back to take the development lead.

Over the next several months, progress was made on Opus. All the required features were coded (though not debugged) and the team declared that the "Code Complete" milestone was reached in October 1988. Code Complete meant that all that remained to be done was to debug and optimize the code for performance. This phase was called "stabilization," and once the code had stabilized (all known bugs were fixed and performance was adequate), the product could be shipped. For scheduling, Microsoft used a rule of thumb that the stabilization phase typically lasted three months.

It soon became clear that Opus was not likely to follow the three month rule. Although developers were fixing bugs quickly, the testers seemed to find new bugs just as quickly (see **Exhibit 5**). During this period, Dormitzer did his best to lead the project, but his illness had not fully abated. Eventually, Mason responded by making McDermott acting development lead in addition to his technical lead responsibilities. At that time, McDermott had been at Microsoft for three years.

McDermott recalled the stabilization period:

> Not having a technical lead who could concentrate on technical issues definitely cost us. The size, speed, and memory usage of Opus could have been made better than it was if the technical lead had not spent the last 18 months as development lead or covering for sick and burned out development leads. The team at this stage had 15 developers, six programmer assistants and seven interns during this period. No one lead could possibly keep tabs on what each person was working on.

Despite the troubles, the Opus program began to stabilize. During the spring of 1989 the number of active bugs remained relatively constant, but, during the summer, an initiative emphasizing the quality of changes rather than the quantity of changes was instituted. For the first time, testing was invited to development code reviews, and ownership of the code was stressed. By late fall of 1989, the program had stabilized and Word for Windows version 1.0 was released on November 30, 1989 (see **Exhibit 6** for a project time line).

Word for Windows' Market Reception

Despite the long delay in the Word for Windows (WinWord) development, only one other company, Samna, had been able to release a full featured word processor for Windows earlier. While it was too early to gauge the customer reception accurately, early signs were very encouraging. One particularly encouraging sign was the reception in the industry press. Reviews in computer magazines and journals wielded great power over the marketplace perceptions, and the reviews had been universally favorable. WinWord was described as easy to use and incredibly bug-free for a first release. Many magazines rated WinWord higher than any other word processor for the PC. (See **Exhibit 7** for a description of competitive products). In response to WinWord's success, WordPerfect announced that it was developing a word processors to run under Windows. WordPerfect for Windows was scheduled for release in February 1991.

WinWord Postmortem

While the WinWord development project had been an extreme case, its problems were not unusual at Microsoft (or for any software development project at any company). In order to learn from the mistakes of previous development projects, Microsoft had instituted a policy of reviewing every project on its completion. The review entailed gathering many statistics on the project as well as holding a series of meetings with project participants in which their views on the project were discussed. While the exact type of statistics varied somewhat from project to project, typically they included estimated versus actual schedule over the course of the project, bug counts over time, code size over time, and milestones scheduled versus actual completion.

These statistics and summaries of the discussions from participant meetings were collected in a document called a postmortem, which was then distributed to all managers in the business group as well as to senior managers. Most postmortems were about 25 pages in length, but the Opus document ran over 100. Extensive statistics had been collected on the project (including those in **Exhibits 1** and 5).

Ideas for Improving Product Development

There were many views on the best way to prevent scheduling fiascos like Opus from recurring. While some of the ideas focused on improvements in the development process, others focused on Microsoft's approach to project management, or on its development strategy.

Process

While the majority of developers enjoyed Microsoft's informal approach, some felt that a more structured development process would substantially improve the company's development performance. This would include relying on more formal project phases and strict milestones, as well as the implementation of formal structured methodologies for software development. Among the developers, McDermott and Mason were advocates of a more structured approach.

McDermott, having lived through the Opus project, had strong views about the causes of its problems:

> A major problem was the lack of an early, clear direction and specification. While we need some flexibility to respond to new information and market changes, from the time development work begins, the major features should be down.

McDermott believed that the development process should have two major clear phases: concept development and implementation. In the first phase, a product concept would be carefully investigated, leading to a complete specification. Once the specification was down, everyone would buy in and implementation would follow without interruptions or delays.

Mason had a different opinion. He had written documents proposing a different approach to improving Microsoft's software development process. He called it "Zero Defects":

> Our goal should be to have a working shippable product every day. This means that when a programmer says a feature is done, it is totally complete: all error and boundary cases work, all interactions with the rest of the product work, and test code and documentation have been checked in.

In this mode of development, the project would begin with a brief period of time in which senior team members would lay out the basic architecture of the software application, breaking it down into several sets of desireable features. These feature sets would then be prioritized. The software coding process would focus on each feature set in a sequential manner. The code would be written in "object-oriented" modules, each of which could be tested independently.

After each module was completed, work would proceed to the next module. This would allow the product to evolve in a controlled fashion, gradually adding subsets of features under the scrutiny of the project's management. This would imply substantial flexibility in the product's specification, since feature sets could be added at any time before (or after) the shipping date. Conversely, this process would also allow meeting virtually any shipping date, with a clear tradeoff between time-to-market and available features. Among the major costs of this approach, however, would be sacrifices in speed and program efficiency: the modularity in the code would make the application substantially slower and larger (in memory usage).

Project Management

Some of the program managers at Microsoft felt that changing the structure of the development process would not be enough to improve things substantially. They felt instead that the root cause of Microsoft's problems was in its approach to project management. The current approach lacked focus and control.

Some program managers felt that their role and position in the organization ought to be strengthened substantially. Their role should evolve to one of "software designer," in charge of conceptualizing and specifying the full range of features and characteristics of the product to be developed. The developers would then simply implement their design in code.

Several program managers emphasized that this approach was consistent with the opinion of several industry experts who felt that the character of the best software applications had changed in recent years. They felt that developing outstanding software now required a much greater attention to detail rather than sheer performance: attention to how the individual features fit together into a well designed, "coherent" product that was attractive, reliable, and fun to use.

Most developers were strongly opposed to turning program managers into designers, however. With a few exceptions, current Microsoft program managers had not previously been

developers. The developers thus felt that program managers simply did not have the level of technical sophistication that was required to really understand the potential of a software development project.

Development Strategy

Other managers emphasized Microsoft's lack of a uniform strategy at the business level as the fundamental problem. They focused on the need for coherence across similar applications, to create economies of scale in development as well as a common "look and feel" in the products.

In 1990, Microsoft was actively writing applications to run on several different operating systems: the main ones were MSDOS, MSDOS with WINDOWS, and the Macintosh. Independent teams would be dedicated to the development of an application for each system. For example, there was a team for Word for the Macintosh, a team for word for DOS, and a team on Word for Windows. Keeping up efforts aimed at different operating systems was putting considerable strain on Microsoft resources. A set of suggestions thus focussed on code sharing within the Applications Division. Different programs required similar components, such as drop-down menus, macro languages, and graphics. Previously written software could often provide similar functionality to a large portion of the routines developed in a typical project. This would create development efficiencies as well as a more consistent user interface across different programs.

On the other hand, as Mason described, sharing code on Opus had cost more time than it saved:

> On WinWord trying to share code with MacWord was a tremendous source of delay. We took a whole bunch of MacWord code at the very beginning—which was fine. The problem came when the Opus made slight changes to optimize the code for WinWord—or just changed it because they felt that the way the MacWord people had done something that was "brain-dead." Then the MacWord people would announce that they had found a whole bunch of bugs in the code they had given Opus. To get those fixes, Opus would then be required to make the same changes so that it was compatible with WinWord. This happened about three or four times. Not only did it delay WinWord by maybe six months, but it probably delayed the release of MacWord version 4.0 by about eight months. To share code, you can have only one set of source code and one group of people modifying it. Sharing 80 percent of the code in a project is good, 20 percent is a nightmare.

Recognition of the code-sharing problem had led to the "core code" approach. In this approach, almost all of the functionality of an application was written in "generic" code which would be shared by the teams working on each individual operating system platform. The Excel business unit had used the approach and Pete Higgins, the general manager, felt that the long term reduction of the development effort would be worth the substantial hiatus in product improvements. No new Excel application had been introduced for a full two year period. Raikes felt that there were also other drawbacks to this approach:

> A risk with the core code standardization approach is that the software tends to get written for a lowest common denominator platform. For example, if you are writing for a PC and a Macintosh, you will tend to use only the features that are common to both. This means that it's difficult to write software that uses all the capabilities of either. Because of this, you may not come out with the best software on either machine and the way the market is today, you need the best software to compete.

Options for the Next Version of WinWord

After a lot of thought, Raikes had boiled down future WinWord project possibilities into two basic options.

The first option involved introducing a new WinWord version (version 2.0) in as rapid a time period as possible. He was pleased with the product's market reception, but he felt that it could use some performance improvements, a few important bug fixes, and the addition of a few features. This was a common strategy at Microsoft. In many cases, it was only when the second version of a new application shipped that its sales really took off - many key customers would wait for the inevitable product improvements before committing to new software. The goal would be to ship WinWord 2.0 in slightly more than one year, or about when WordPerfect had announced it would enter the Windows market. This would involve a highly focused effort, and Raikes doubted that it could be combined with the major improvements in development process and strategy suggested above.

The second option was to postpone the introduction of WinWord 2.0, but use the project to substantially improve the product development process in his business unit. He could experiment with freezing the product's specification, as suggested by McDermott or with Mason's modular approach. Additionally, he could focus the team on "core code" development. Word for DOS, MacWord and WinWord would be rewritten so that 80% of the code was common and only a small part was machine specific. Raikes expected that working on these improvements would add substantial delays to the shipment of WinWord 2.0, ranging from one to two years. Perhaps most important, it would add substantial uncertainties, since these approaches were relatively novel at Microsoft.

In each option, a team of approximately ten programmers and four programmer assistants would be assigned to the project. This was Microsoft's standard team size and had been chosen because Microsoft's management felt that it was the largest practical team. Raikes was uncertain about having enough resources to emphasize more than one project, since there was a limited number of outstanding, experienced developers available.

As Raikes considered his options, his primary goal was clear—he wanted Microsoft to surpass WordPerfect and develop the best-selling word processing software in the world. Achieving such a goal would be difficult, but Raikes felt that if he chose the correct development option and managed the project well, it was possible.

Exhibit 1 Actual vs. Projected Schedule

Report Date	Estimated Ship Date	Estimated Days to Ship	Actual Days to Ship
Sep-84	Sep-85	365	2,187
Jun-85	Jul-86	395	1,614
Jan-86	Nov-86	304	1,400
Jun-86	May-87	334	1,245
Jan-87	Dec-87	334	1,035
Jun-87	Feb-88	245	884
Jan-88	Jun-88	152	670
Jun-88	Oct-88	122	518
Aug-88	Jan-89	153	457
Oct-88	Feb-89	123	396
Jan-89	May-89	120	304
Jun-89	Sep-89	92	153
Jul-89	Oct-89	92	123
Aug-89	Nov-89	92	92
Nov-89	Nov-89	0	0

Exhibit 2 Financial Information ($ millions)

	Fiscal Year Ending		
	6/30/89	6/30/88	6/30/87
Net Sales	804	591	346
Cost of Goods	204	148	74
Gross Profit	599	443	272
Research and Development Expense	110	70	38
Selling, General and Administrative	247	186	107
Non-Operating Income	9	(4)	(6)
Interest Expense	0	0	0
Income Before Taxes	251	184	121
Provision for Income Taxes	80	60	49
Net Income	171	124	72

Source: *The Wall Street Journal*, May 21, 1990, p. A4, reprinted with permission.

Exhibit 3 Microsoft's Product Line and Market Shares (estimated for 1990)

Product Line	Sales ($ millions)	Market Share[a]	Market Rank
IBM PC Operating Systems	$300	98%	1
MS-DOS, PC-DOS	130	91	1
OS/2	56	5	3
Xenix	14	2	4
Windows (requires DOS)	100	15	2
PC Languages	95	70	1
C	50	65	1
Pascal[b]	10	35	2
FORTRAN	35	92	1
PC Applications	430	9	2
Excel (windows spreadsheet)	120	15	2
Multiplan (spreadsheet)[c]	10	1	8
Word (word processor)	250	30	2
Word for Windows	50	6	6
Macintosh Languages	17	80	1
C	9	85	1
Pascal	2	55	1
BASIC	6	95	1
Macintosh Applications	140	25	1
Excel (spreadsheet)	70	90	1
Mac Word (word processor)	70	80	1

[a]Market share was defined as the percent of sales in the particular product category. For example the market share of Word for Windows was defined with respect to all PC wordprocessors (but not including Macintosh word processors). It should be mentioned that the market shares for PC operating systems total over 100% because all Windows systems must have DOS as well.

[b]Borland was the leader in this category with Turbo Pascal with approximately $20 million in annual sales and a 60% market share.

[c]Lotus dominated this category with 1-2-3 Release 2.2 with $230 million in sales and 1-2-3 Release 3.0 with $120 million in sales annually. Borland's Quattro Pro was also a player in this category with $60 million in sales.

Exhibit 4 Microsoft Organization Chart, 1990

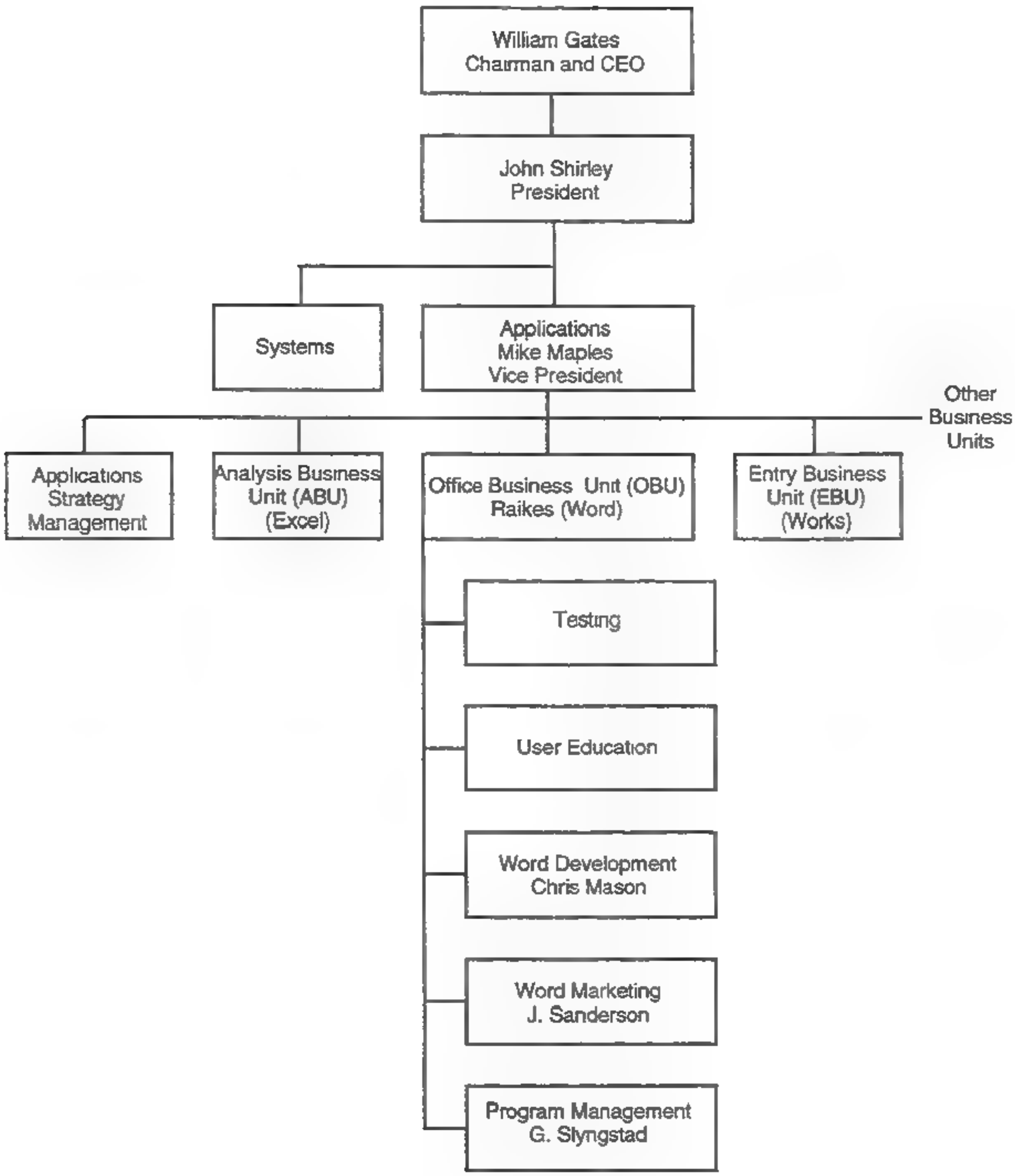


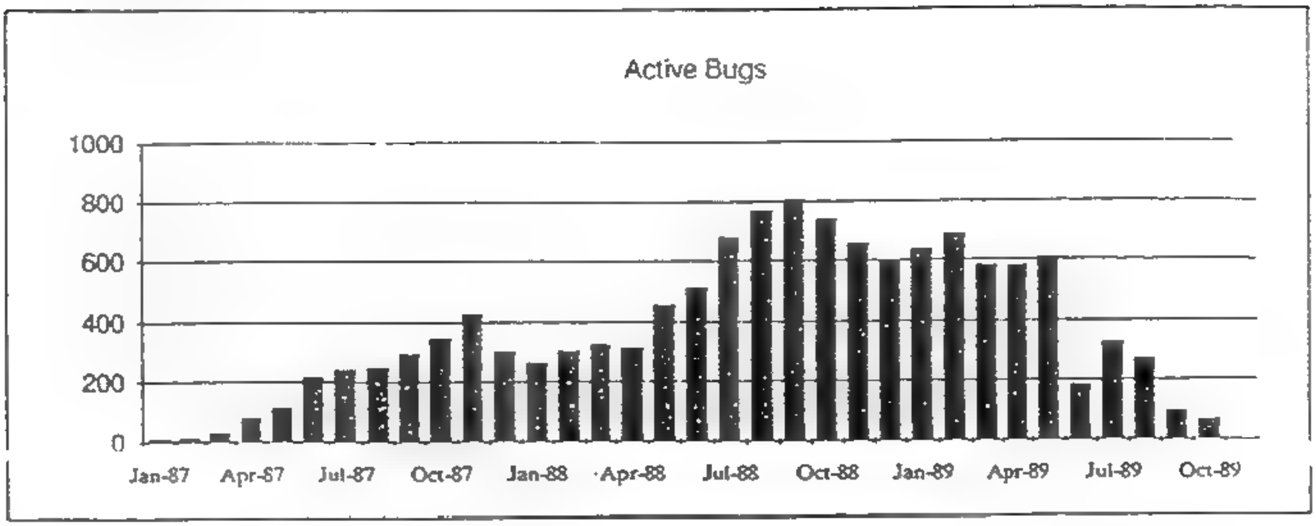
Exhibit 5 Data from Opus Portmortem

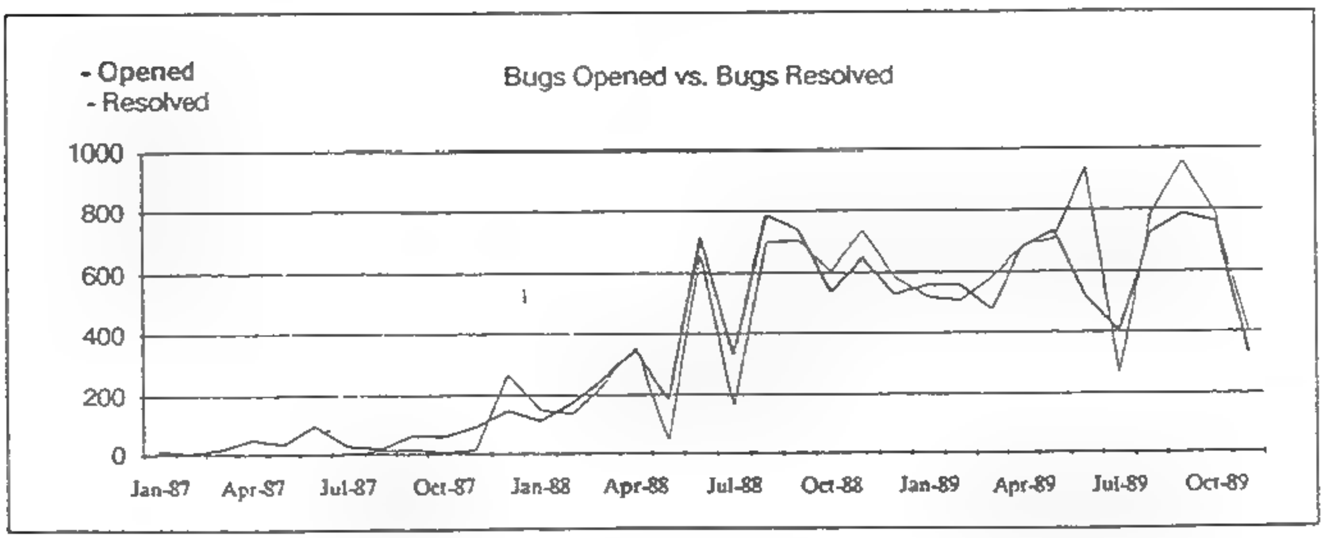
Statistics	
Size of shipped product	852,576 bytes[a]
Number of lines of program instructions (code)	249,000
Total development time spent (including part-time members	55 person-years
Number of lines of code present at "code complete"	209,000

One "byte" corresponds to a unit of computer memory storage roughly comparable to that required by one character of text.

asm = assembly language code.

Exhibit 5 (continued)





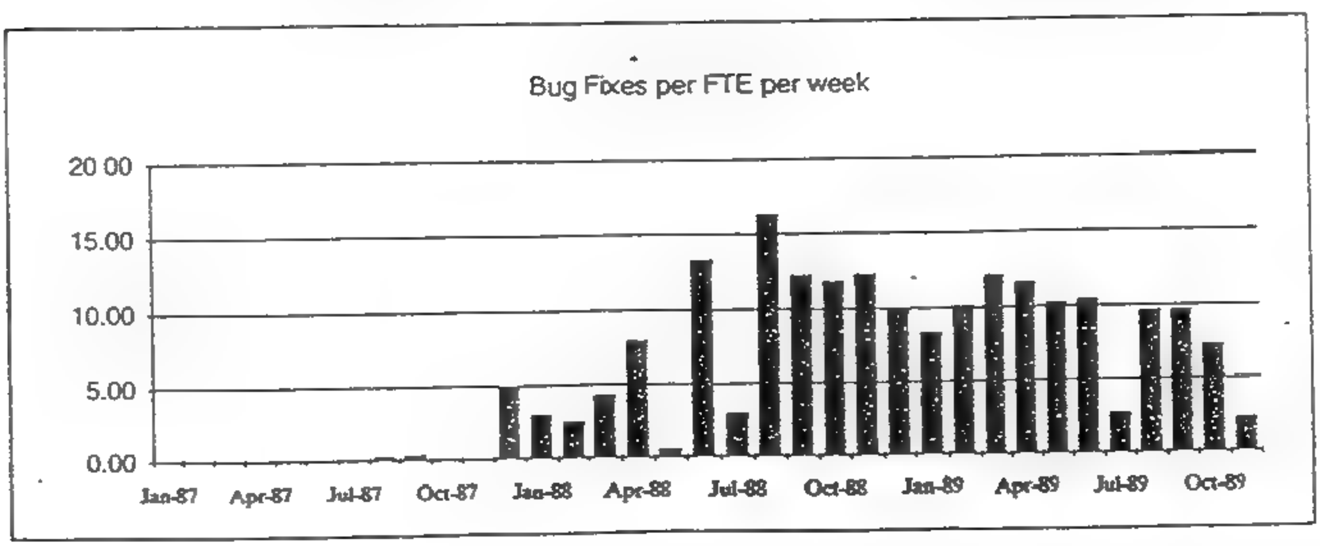
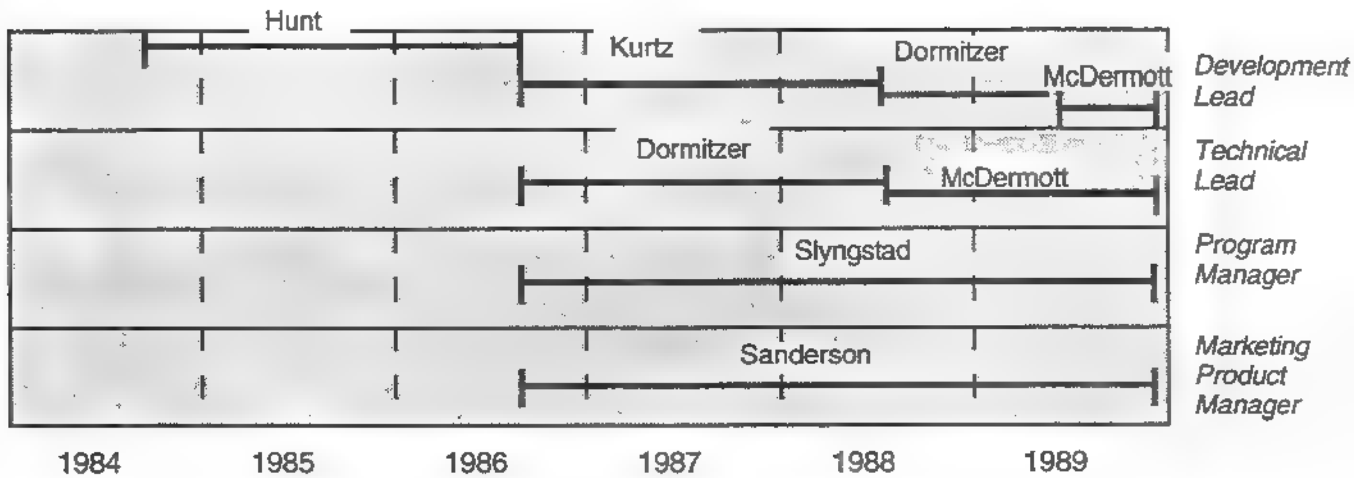


Exhibit 6 Time Line of the Cashmere/Opus Project

Cashmere/Opus Leadership



Cashmere/Opus Events

Date	Event
8/84	Winword project beings
8/85	Coding begins
9/85	First demonstration to Bill Gates
11/85	Coding work intensified
1/87	Testing work begins
4/87	Specification discussed with Bill Gates
6/87	Revised specification distributed
10/87	Addendum to final specification distributed
12/87	Visual freeze: the way the program looks to the user is officially established
2/88	Presentation to Bill Gates; additional features added
3/88	Addendum to final specification distributed
6/88	Almost all features reported to be "working to some degree"
7/88	Addendum to final specification distributed
8/88	Feature complete: no more features added after this point
10/88	Code complete
3/89	Performance optimization declared complete
10/89	Word for Windows is officially announced
11/89	Word for Windows ships

Exhibit 7 The PC Word Processing Software Market

Word processing software was the largest segment of the applications software market for IBM PCs and compatibles. Over $800 million was spent annually on professional word processors, the high end of the word processor market. This market segment was dominated by a few players, all of which were character-based in 1990.

WordPerfect, Version 5.1

WordPerfect version 5.1 was the latest in a long line of updates of a highly successful product. WordPerfect had the largest share of the word processor market at 45%. In product comparisons, WordPerfect generally won on the number of features it had and the wide variety of printers it supported. WordPerfect was also available on a wide variety of non-DOS computers including the Apple Macintosh, Digital Equipment Corporation's VAX line, and IBM mainframes. Although WordPerfect was character based, WordPerfect Corporation had announced that a Windows version was under development and was expected to ship in the first quarter of 1991.

Word for DOS, Version 5.0

Microsoft's original high-end, character-based wordprocessor for DOS had first been released in 1983, but had not received good reviews in industry magazines or achieved much market success. Since then, however, Microsoft had continually improved the product to the point where it was rated on a par with WordPerfect, and much higher than any other word processors. Word's market share had improved correspondingly and was now the second highest at 30%.

Wordstar, Version 5.5

Wordstar Corporation had first developed a word processor for the CP/M computer market (a predecessor of IBM/DOS). Dominant in the CP/M market, it had translated its software to run under DOS in 1982, and had quickly become the market leader. Since that time, however, its updates had not kept pace with the rest of the market and the product had fallen behind technically. Its market share in 1990 was 12%, well below the market leaders.

Displaywrite 4

IBM's entry in the word processing software market was generally considered to be an inferior product to either of the two market leaders. Its limited market success (10% share) was attributed to IBM's dominance in the hardware market. Its market share had been declining for several years.

Exhibit 8 Word Processor Operating Environments

	Macintosh		IBM PC and Compatibles		
Operating System	**Mac/OS**	**DOS**	**DOS**	**OS/2**	**OS/2**
Layered Product[a]	—	—	Windows	—	Presentation Manager
Interface Type	GUI[b]	Character	GUI	Character	GUI
MicrosoftWord Processor	Word for Macintosh	Word for DOS	Word for Windows	—	—
WYSIWYG [c]	yes	no	yes	—	—

[a]The layered product is an add-on to the basic operating systems which provides a more uniform and easy-to-use user interface. The Mac/OS was designed from the ground up to provide such capabilities, whereas DOS and OS/2 do not. For this reason, Microsoft has developed Windows for DOS and the Presentation Manager for OS/2 to provide similar capabilities.

[b]GUI stands for Graphical User Interface, where the user gives commands to the computer by using a mouse to point to icons on a graphics screen.

[c]WYSIWYG stands for What You See Is What You Get. It refers to applications where the screen display closely resembles printed output.

Exhibit 8
Word Processor Operating Environments

	Macintosh	IBM PC and Compatibles			
Operating System	Mac/OS	DOS	DOS	OS/2	OS/2
Layered Product (1)	–	–	Windows	–	Presentation Manager
Interface Type	GUI (2)	Character	GUI	Character	GUI
Microsoft Word Processor	Word for Macintosh	Word for DOS	Word for Windows	–	–
WYSIWYG (3)	yes	no	yes	–	–

(1) The layered product is an add-on to the basic operating systems which provides a more uniform and easy-to-use user interface. The Mac/OS was designed from the ground up to provide such capabilities, whereas DOS and OS/2 do not. For this reason, Microsoft has developed Windows for DOS and the Presentation Manager for OS/2 to provide similar capabilities.

(2) GUI stands for Graphical User Interface, where the user gives commands to the computer by using a mouse to point to icons on a graphics screen.

(3) WYSIWYG stands for What You See Is What You Get. It refers to applications where the screen display closely resembles printed output.

Appendix 1
Background on Software Development Methodology in 1990

A software development project could be divided into six phases: (1) conceptualization; (2) specification; (3) design; (4) coding; (5) integration; and (6) testing and debug. While the distinctions between different phases were not always clear and there was a great deal of overlap between phases, most companies set milestones according to these (or similar) phases.

The Conceptualization Phase

In this phase, the basic scope and purpose of the software project were determined. Generally, only a small amount of effort was expended in this phase and often the only tangible output was a short (1-3 pages) memo by a senior engineer or manager describing the basic goals of the proposed project.

The Specification Phase

This phase was similar to the conceptualization phase in that its purpose was to describe the software's purpose and functionality. It differed in that the software specifications document produced during this phase contained much more detail than the earlier conceptualization document -- 100-page specifications were not unusual. Although in some companies the marketing group had complete responsibility for developing specifications which were then passed on to the development group, the specifications phase was a joint effort by developers and marketers at most companies. Specifying the functionality of the software in such detail required implicit design decisions which blurred the distinction between the specifications and the design phases.

The Design Phase

Working from the software specifications, the software developers designed the basic structure of the software. During this phase, the developers would break up the development task into a series of smaller tasks, which in turn were further divided until they became small enough to be completed with relative ease. This logical breakdown was then translated to a physical breakdown where the program was divided into a collection of subprograms.

A complete software design had the following elements: (1) a complete list of all the subprograms; (2) a description of the function of each of the subprograms; (3) a description of the algorithm that each of the subprograms would use; (4) a list of inputs (data, disk files, peripheral devices requirements, etc.) that each of the subprograms needed to complete its function; (5) a list of outputs that each of the subprograms produced.

In complex software systems, such as those developed at Microsoft, there usually were thousands of subprograms. Because of this complexity, it was very rare that complete designs were ever developed before the software was written. Often technical issues would be raised that could not be resolved without actually writing portions of the software to explore them.

In general, the designers would go down several levels of subprogram in a design, and then assign each of the subprograms to a software engineer to develop. The software engineers usually had to do further design of their subprogram, but the work of each was largely independent of the other engineers working on the project.

The Coding Phase

Coding was the common name for writing the sets of English-like commands (called code) that the software developers used to instruct the computer on what actions to perform. This effort was done in parallel, with each engineer responsible for coding, testing, and debugging his or her portion of the program.

The Integration Phase

In this phase, all the subprograms written by the individual software engineers were linked together to create the full program. Flaws and inconsistencies in the design commonly became apparent during this period. Often the designers did not realize that a particular data item would be required in a particular subprogram. Sometimes more fundamental flaws in the design's structure were found, creating problems that were impossible or impractical to resolve within the given structure. For this reason, the software developers and designers needed to have frequent communication to keep all parties informed of the changes. These communications could take many forms including meetings, memos, and reports. At Microsoft, electronic mail (E-mail) was very heavily used with employees often sending and receiving dozens of messages a day.

In addition, when the all the subprograms were finally integrated, the complete program's performance (in particular its speed and memory requirements) would often be inadequate. During this phase the developers often had try to consolidate subprograms and optimize overall performance.

Testing and Debug

While testing and debugging occurred throughout the development process, usually there was no formalized process until the software was essentially complete. At some point, usually early in the integration phase, an early version of the program would be given to testers whose job it was to try to find bugs (errors). When found, these bugs were reported to the programmers who had to track down and correct them (debugging).

Manual testing of the programs often became impractical because every time a bug was fixed, all the tests had to be run to make sure that the "fix" had not introduced a new bug. For this reason, Microsoft tried to automate the testing process where ever possible. For large and/or complex programs, this automation often required writing almost as much software to test the program as the program required itself.

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Reengineering Work: Don't Automate, Obliterate

by Michael Hammer

Harvard Business Review

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Managers can release the real power of computers by challenging centuries-old notions about work.

Reengineering Work: Don't Automate, Obliterate

by Michael Hammer

Despite a decade or more of restructuring and downsizing, many U.S. companies are still unprepared to operate in the 1990s. In a time of rapidly changing technologies and ever-shorter product life cycles, product development often proceeds at a glacial pace. In an age of the customer, order fulfillment has high error rates and customer inquiries go unanswered for weeks. In a period when asset utilization is critical, inventory levels exceed many months of demand.

The usual methods for boosting performance – process rationalization and automation – haven't yielded the dramatic improvements companies need. In particular, heavy investments in information technology have delivered disappointing results – largely because companies tend to use technology to mechanize old ways of doing business. They leave the existing processes intact and use computers simply to speed them up.

> Use computers to redesign – not just automate – existing business processes.

But speeding up those processes cannot address their fundamental performance deficiencies. Many of our job designs, work flows, control mechanisms, and organizational structures came of age in a different competitive environment and before the advent of the computer. They are geared toward efficiency and control. Yet the watchwords of the new decade are innovation and speed, service and quality.

It is time to stop paving the cow paths. Instead of embedding outdated processes in silicon and software, we should obliterate them and start over. We should "reengineer" our businesses: use the power of modern information technology to radically redesign our business processes in order to achieve dramatic improvements in their performance.

Every company operates according to a great many unarticulated rules. "Credit decisions are made by the credit department." "Local inventory is needed for good customer service." "Forms must be filled in completely and in order." Reengineering strives to break away from the old rules about how we organize

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and conduct business. It involves recognizing and rejecting some of them and then finding imaginative new ways to accomplish work. From our redesigned processes, new rules will emerge that fit the times. Only then can we hope to achieve quantum leaps in performance.

Reengineering cannot be planned meticulously and accomplished in small and cautious steps. It's an all-or-nothing proposition with an uncertain result. Still, most companies have no choice but to muster the courage to do it. For many, reengineering is the only hope for breaking away from the antiquated processes that threaten to drag them down. Fortunately, managers are not without help. Enough businesses have successfully reengineered their processes to provide some rules of thumb for others.

What Ford and MBL Did

Japanese competitors and young entrepreneurial ventures prove every day that drastically better levels of process performance are possible. They develop products twice as fast, utilize assets eight times more productively, respond to customers ten times faster. Some large, established companies also show what can be done. Businesses like Ford Motor Company and Mutual Benefit Life Insurance have reengineered their processes and achieved competitive leadership as a result. Ford has reengineered its accounts payable processes, and Mutual Benefit Life, its processing of applications for insurance.

In the early 1980s, when the American automotive industry was in a depression, Ford's top management put accounts payable–along with many other departments–under the microscope in search of ways to cut costs. Accounts payable in North America alone employed more than 500 people. Management thought that by rationalizing processes and installing new computer systems, it could reduce the head count by some 20%.

Ford was enthusiastic about its plan to tighten accounts payable–until it looked at Mazda. While Ford was aspiring to a 400-person department, Mazda's accounts payable organization consisted of a total of 5 people. The difference in absolute numbers was astounding, and even after adjusting for Mazda's smaller size, Ford figured that its accounts payable organization was five times the size it should be. The Ford team knew better than to attribute the discrepancy to calisthenics, company songs, or low interest rates.

Ford managers ratcheted up their goal: accounts payable would perform with not just a hundred but many hundreds fewer clerks. It then set out to achieve it. First, managers analyzed the existing system. When Ford's purchasing department wrote a purchase order, it sent a copy to accounts payable. Later, when material control received the goods, it sent a copy of the receiving document to accounts payable. Meanwhile, the vendor sent an invoice to accounts payable. It was up to accounts payable, then, to match the purchase order against the receiving document and the invoice. If they matched, the department issued payment.

The department spent most of its time on mismatches, instances where the purchase order, receiving document, and invoice disagreed. In these cases, an accounts payable clerk would investigate the discrepancy, hold up payment, generate documents, and all in all gum up the works.

One way to improve things might have been to help the accounts payable clerk investigate more efficiently, but a better choice was to prevent the mismatches in the first place. To this end, Ford instituted "invoiceless processing." Now when the purchasing department initiates an order, it enters the information into an on-line database. It doesn't send a copy of the purchase order to anyone. When the goods arrive at the receiving dock, the receiving clerk checks the database to see if they correspond to an outstanding purchase order. If so, he or she accepts them and enters the transaction into the computer system. (If receiving can't find a database entry for the received goods, it simply returns the order.)

Under the old procedures, the accounting department had to match 14 data items between the receipt record, the purchase order, and the invoice before it could issue payment to the vendor. The new approach requires matching only three items–part number, unit of measure, and supplier code–between the purchase order and the receipt record. The matching is done automatically, and the computer prepares the check, which accounts payable sends to the vendor. There are no invoices to worry about since Ford has asked its vendors not to send them. (See the diagram, "Ford's Accounts Payable Process...," for illustrations of the old and new payables processes.)

> **Why did Ford need 400 accounts payable clerks when Mazda had just 5?**

Ford didn't settle for the modest increases it first envisioned. It opted for radical change–and achieved dramatic improvement. Where it has instituted this

new process, Ford has achieved a 75% reduction in head count, not the 20% it would have gotten with a conventional program. And since there are no discrepancies between the financial record and the physical record, material control is simpler and financial information is more accurate.

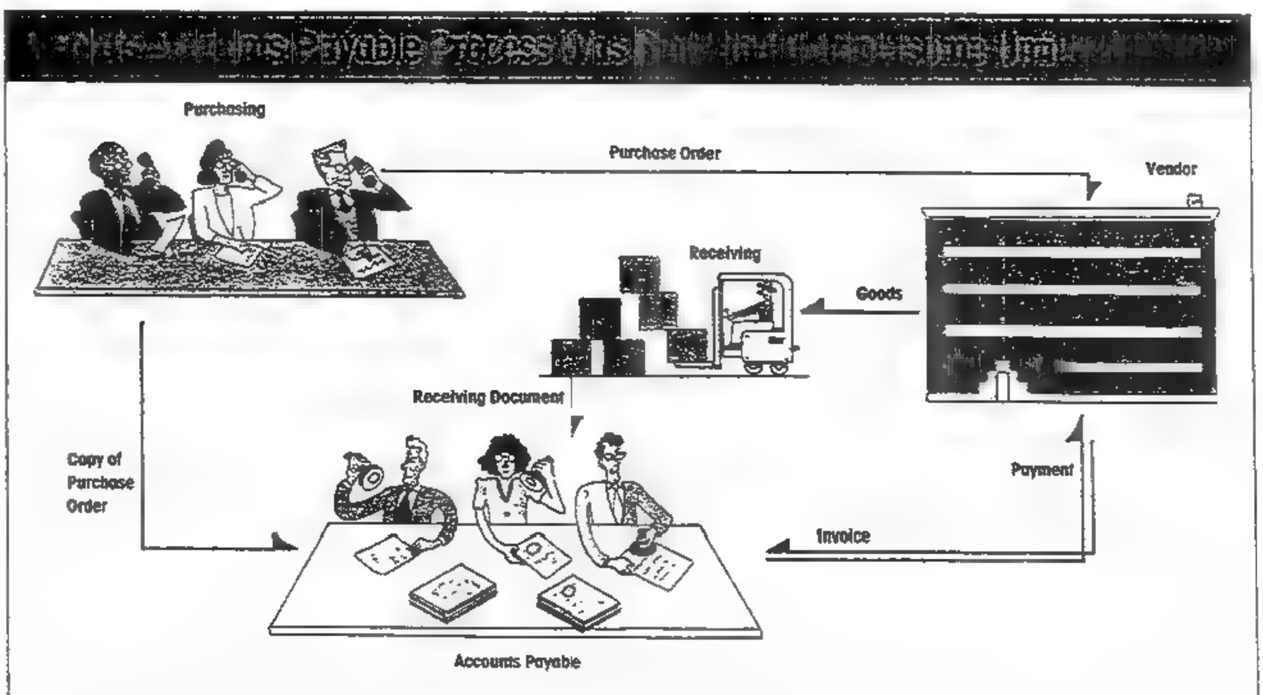
Mutual Benefit Life, the country's eighteenth largest life carrier, has reengineered its processing of insurance applications. Prior to this, MBL handled customers' applications much as its competitors did. The long, multistep process involved credit checking, quoting, rating, underwriting, and so on. An application would have to go through as many as 30 discrete steps, spanning 5 departments and involving 19 people. At the very best, MBL could process an application in 24 hours, but more typical turnarounds ranged from 5 to 25 days—most of the time spent passing information from one department to the next. (Another insurer estimated that while an application spent 22 days in process, it was actually worked on for just 17 minutes.)

MBL's rigid, sequential process led to many complications. For instance, when a customer wanted to cash in an existing policy and purchase a new one, the old business department first had to authorize the treasury department to issue a check made payable to MBL. The check would then accompany the paperwork to the new business department.

The president of MBL, intent on improving customer service, decided that this nonsense had to stop and demanded a 60% improvement in productivity. It was clear that such an ambitious goal would require more than tinkering with the existing process. Strong measures were in order, and the management team assigned to the task looked to technology as a means of achieving them. The team realized that shared databases and computer networks could make many different kinds of information available to a single person, while expert systems could help people with limited experience make sound decisions. Applying these insights led to a new approach to the application-handling process, one with wide organizational implications and little resemblance to the old way of doing business.

MBL swept away existing job definitions and departmental boundaries and created a new position called a case manager. Case managers have total responsibility for an application from the time it is received to the time a policy is issued. Unlike clerks, who performed a fixed task repeatedly under the watchful gaze of a supervisor, case managers work autonomously. No more handoffs of files and responsibility, no more shuffling of customer inquiries.

Case managers are able to perform all the tasks associated with an insurance application because they are supported by powerful PC-based workstations that run an expert system and connect to a range of automated systems on a mainframe. In particularly tough cases, the case manager calls for assistance from a senior underwriter or physician, but these spe-



More than 500 accounts payable clerks matched purchase orders, receiving documents, and invoices and then issued payment. Mismatches were common.

DRAWINGS BY GARISON WEILAND

cialists work only as consultants and advisers to the case manager, who never relinquishes control.

Empowering individuals to process entire applications has had a tremendous impact on operations. MBL can now complete an application in as little as four hours, and average turnaround takes only two to five days. The company has eliminated 100 field office positions, and case managers can handle more than twice the volume of new applications the company previously could process.

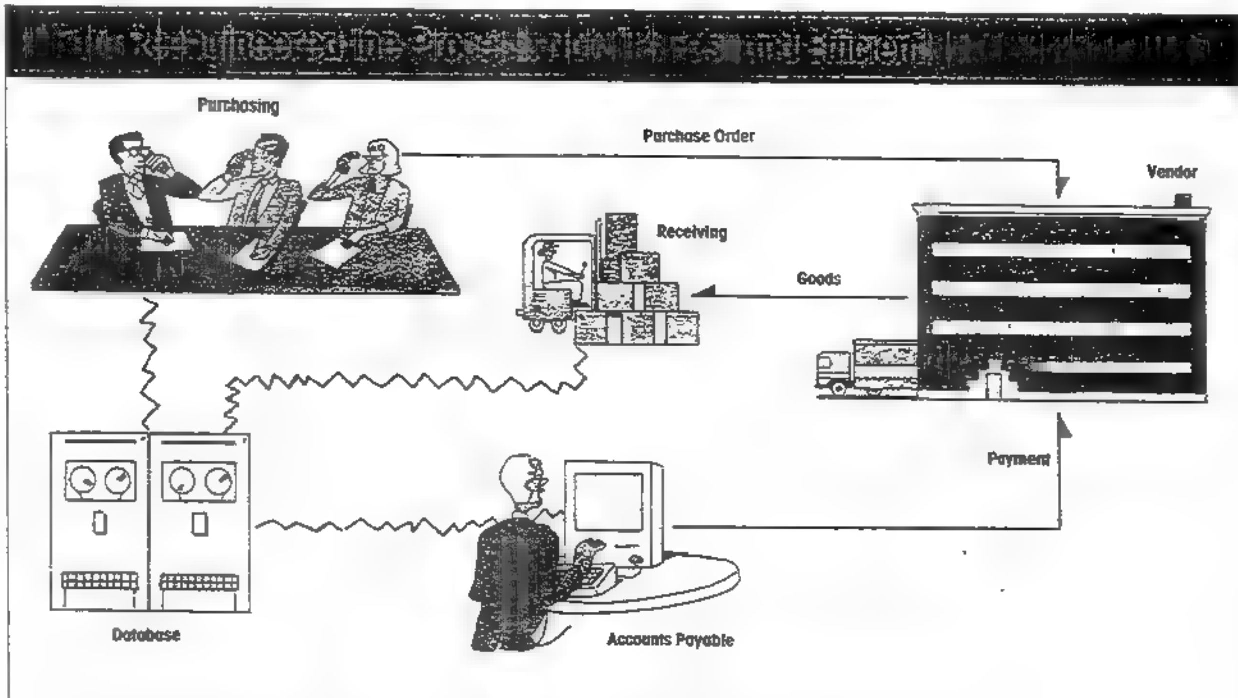
The Essence of Reengineering

At the heart of reengineering is the notion of discontinuous thinking–of recognizing and breaking away from the outdated rules and fundamental assumptions that underlie operations. Unless we change these rules, we are merely rearranging the deck chairs on the Titanic. We cannot achieve breakthroughs in performance by cutting fat or automating existing processes. Rather, we must challenge old assumptions and shed the old rules that made the business underperform in the first place.

Every business is replete with implicit rules left over from earlier decades. "Customers don't repair their own equipment." "Local warehouses are necessary for good service." "Merchandising decisions are made at headquarters." These rules of work design are based on assumptions about technology, people, and organizational goals that no longer hold. The contemporary repertoire of available information technologies is vast and quickly expanding. Quality, innovation, and service are now more important than cost, growth, and control. A large portion of the population is educated and capable of assuming responsibility, and workers cherish their autonomy and expect to have a say in how the business is run.

It should come as no surprise that our business processes and structures are outmoded and obsolete: our work structures and processes have not kept pace with the changes in technology, demographics, and business objectives. For the most part, we have organized work as a sequence of separate tasks and employed complex mechanisms to track its progress. This arrangement can be traced to the Industrial Revolution, when specialization of labor and economies of scale promised to overcome the inefficiencies of cottage industries. Businesses disaggregated work into narrowly defined tasks, reaggregated the people performing those tasks into departments, and installed managers to administer them.

Our elaborate systems for imposing control and discipline on those who actually do the work stem from the postwar period. In that halcyon period of expansion, the main concern was growing fast without going broke, so businesses focused on cost, growth, and control. And since literate, entry-level people were abundant but well-educated professionals hard



The new process cuts head count in accounts payable by 75%, eliminates invoices, and improves accuracy. Matching is computerized.

to come by, the control systems funneled information up the hierarchy to the few who presumably knew what to do with it.

These patterns of organizing work have become so ingrained that, despite their serious drawbacks, it's hard to conceive of work being accomplished any other way. Conventional process structures are fragmented and piecemeal, and they lack the integration necessary to maintain quality and service. They are breeding grounds for tunnel vision, as people tend to substitute the narrow goals of their particular

Ford's old rule: we pay when we get the invoice. Ford's new rule: we pay when we get the goods.

department for the larger goals of the process as a whole. When work is handed off from person to person and unit to unit, delays and errors are inevitable. Accountability blurs, and critical issues fall between the cracks. Moreover, no one sees enough of the big picture to be able to respond quickly to new situations. Managers desperately try, like all the king's horses and all the king's men, to piece together the fragmented pieces of business processes.

Managers have tried to adapt their processes to new circumstances, but usually in ways that just create more problems. If, say, customer service is poor, they create a mechanism to deliver service but overlay it on the existing organization. Bureaucracy thickens, costs rise, and enterprising competitors gain market share.

In reengineering, managers break loose from outmoded business processes and the design principles underlying them and create new ones. Ford had operated under the old rule that "We pay when we receive the invoice." While no one had ever articulated or recorded it, that rule determined how the accounts payable process was organized. Ford's reengineering effort challenged and ultimately replaced the rule with a new one: "We pay when we receive the *goods*."

Reengineering requires looking at the fundamental processes of the business from a cross-functional perspective. Ford discovered that reengineering only the accounts payable department was futile. The appropriate focus of the effort was what might be called the goods acquisition process, which included purchasing and receiving as well as accounts payable.

One way to ensure that reengineering has a cross-functional perspective is to assemble a team that represents the functional units involved in the process being reengineered and all the units that depend on it. The team must analyze and scrutinize the existing process until it really understands what the process is trying to accomplish. The point is not to learn what happens to form 73B in its peregrinations through the company but to understand the purpose of having form 73B in the first place. Rather than looking for opportunities to improve the current process, the team should determine which of its steps really add value and search for new ways to achieve the result.

The reengineering team must keep asking Why? and What if? Why do we need to get a manager's signature on a requisition? Is it a control mechanism or a decision point? What if the manager reviews only requisitions above $500? What if he or she doesn't see them at all? Raising and resolving heretical questions can separate what is fundamental to the process from what is superficial. The regional offices of an East Coast insurance company had long produced a series of reports that they regularly sent to the home office. No one in the field realized that these reports were simply filed and never used. The process outlasted the circumstances that had created the need for it. The reengineering study team should push to discover situations like this.

In short, a reengineering effort strives for dramatic levels of improvement. It must break away from conventional wisdom and the constraints of organizational boundaries and should be broad and cross-functional in scope. It should use information technology not to automate an existing process but to enable a new one.

Principles of Reengineering

Creating new rules tailored to the modern environment ultimately requires a new conceptualization of the business process—which comes down to someone having a great idea. But reengineering need not be haphazard. In fact, some of the principles that companies have already discovered while reengineering their business processes can help jump start the effort for others.

Organize around outcomes, not tasks. This principle says to have one person perform all the steps in a process. Design that person's job around an objective or outcome instead of a single task. The redesign at Mutual Benefit Life, where individual case managers perform the entire application approval process, is the quintessential example of this.

The redesign of an electronics company is another example. It had separate organizations performing

each of the five steps between selling and installing the equipment. One group determined customer requirements, another translated those requirements into internal product codes, a third conveyed that information to various plants and warehouses, a fourth received and assembled the components, and a fifth delivered and installed the equipment. The process was based on the centuries-old notion of specialized labor and on the limitations inherent in paper files. The departments each possessed a specific set of skills, and only one department at a time could do its work.

The customer order moved systematically from step to step. But this sequential processing caused problems. The people getting the information from the customer in step one had to get all the data anyone would need throughout the process, even if it wasn't needed until step five. In addition, the many handoffs were responsible for numerous errors and misunderstandings. Finally, any questions about customer requirements that arose late in the process had to be referred back to the people doing step one, resulting in delay and rework.

When the company reengineered, it eliminated the assembly-line approach. It compressed responsibility for the various steps and assigned it to one person, the "customer service representative." That person now oversees the whole process—taking the order, translating it into product codes, getting the components assembled, and seeing the product delivered and installed. The customer service rep expedites and coordinates the process, much like a general contractor. And the customer has just one contact, who always knows the status of the order.

Have those who use the output of the process perform the process. In an effort to capitalize on the benefits of specialization and scale, many organizations established specialized departments to handle specialized processes. Each department does only one type of work and is a "customer" of other groups' processes. Accounting does only accounting. If it needs new pencils, it goes to the purchasing department, the group specially equipped with the information and expertise to perform that role. Purchasing finds vendors, negotiates price, places the order, inspects the goods, and pays the invoice—and eventually the accountants get their pencils. The process works (after a fashion), but it's slow and bureaucratic.

Now that computer-based data and expertise are more readily available, departments, units, and individuals can do more for themselves. Opportunities exist to reengineer processes so that the individuals who need the result of a process can do it themselves. For example, by using expert systems and databases, departments can make their own purchases without sacrificing the benefits of specialized purchasers. One manufacturer has reengineered its purchasing process along just these lines. The company's old system, whereby the operating departments submitted requisitions and let purchasing do the rest, worked well for controlling expensive and important items like raw materials and capital equipment. But for inexpensive and nonstrategic purchases, which constituted some 35% of total orders, the system was slow and cumbersome; it was not uncommon for the cost of the purchasing process to exceed the cost of the goods being purchased.

The new process compresses the purchase of sundry items and pushes it on to the customers of the process. Using a database of approved vendors, an operating unit can directly place an order with a vendor and charge it on a bank credit card. At the end of the month, the bank gives the manufacturer a tape of all credit card transactions, which the company runs against its internal accounting system.

When an electronics equipment manufacturer reengineered its field service process, it pushed some of the steps of the process on to its customers. The manufacturer's field service had been plagued by the usual problems: technicians were often unable to do a particular repair because the right part wasn't on the van, response to customer calls was slow, and spare-parts inventory was excessive.

> Must technicians make repairs? Or can computers help customers make their own?

Now customers make simple repairs themselves. Spare parts are stored at each customer's site and managed through a computerized inventory-management system. When a problem arises, the customer calls the manufacturer's field-service hot line and describes the symptoms to a diagnostician, who accesses a diagnosis support system. If the problem appears to be something the customer can fix, the diagnostician tells the customer what part to replace and how to install it. The old part is picked up and a new part left in its place at a later time. Only for complex problems is a service technician dispatched to the site, this time without having to make a stop at the warehouse to pick up parts.

When the people closest to the process perform it, there is little need for the overhead associated with managing it. Interfaces and liaisons can be eliminated, as can the mechanisms used to coordinate those who perform the process with those who use it.

Why Did We Design Inefficient Processes?

In a way, we didn't. Many of our procedures were not designed at all; they just happened. The company founder one day recognized that he didn't have time to handle a chore, so he delegated it to Smith. Smith improvised. Time passed, the business grew, and Smith hired his entire clan to help him cope with the work volume. They all improvised. Each day brought new challenges and special cases, and the staff adjusted its work accordingly. The hodgepodge of special cases and quick fixes was passed from one generation of workers to the next.

We have institutionalized the ad hoc and enshrined the temporary. Why do we send foreign accounts to the corner desk? Because 20 years ago, Mary spoke French and Mary had the corner desk. Today Mary is long gone, and we no longer do business in France, but we still send foreign accounts to the corner desk. Why does an electronics company spend $10 million a year to manage a field inventory worth $20 million? Once upon a time, the inventory was worth $200 million, and managing it cost $5 million. Since then, warehousing costs have escalated, components have become less expensive, and better forecasting techniques have minimized units in inventory. But the inventory procedures, alas, are the same as always.

Of the business processes that *were* designed, most took their present forms in the 1950s. The goal then was to check overambitious growth – much as the typewriter keyboard was designed to slow typists who would otherwise jam the keys. It is no accident that organizations stifle innovation and creativity. That's what they were *designed* to do.

Nearly all of our processes originated before the advent of modern computer and communications technology. They are replete with mechanisms designed to compensate for "information poverty." Although we are now information affluent, we still use those mechanisms, which are now deeply embedded in automated systems.

Moreover, the problem of capacity planning for the process performers is greatly reduced.

Subsume information-processing work into the real work that produces the information. The previous two principles say to compress linear processes. This principle suggests moving work from one person or department to another. Why doesn't an organization that produces information also process it? In the past, people didn't have the time or weren't trusted to do both. Most companies established units to do nothing but collect and process information that other departments created. This arrangement reflects the old rule about specialized labor and the belief that people at lower organizational levels are incapable of acting on information they generate. An accounts payable department collects information from purchasing and receiving and reconciles it with data that the vendor provides. Quality assurance gathers and analyzes information it gets from production.

Ford's redesigned accounts payable process embodies the new rule. With the new system, receiving, which produces the information about the goods received, processes this information instead of sending it to accounts payable. The new computer system can easily compare the delivery with the order and trigger the appropriate action.

Treat geographically dispersed resources as though they were centralized. The conflict between centralization and decentralization is a classic one. Decentralizing a resource (whether people, equipment, or inventory) gives better service to those who use it, but at the cost of redundancy, bureaucracy, and missed economies of scale. Companies no longer have to make such trade-offs. They can use databases, telecommunications networks, and standardized processing systems to get the benefits of scale and coordination while maintaining the benefits of flexibility and service.

At Hewlett-Packard, for instance, each of the more than 50 manufacturing units had its own separate purchasing department. While this arrangement provided excellent responsiveness and service to the plants, it prevented H-P from realizing the benefits of its scale, particularly with regard to quantity discounts. H-P's solution is to maintain the divisional purchasing organizations and to introduce a corporate unit to coordinate them. Each purchasing unit has access to a shared database on vendors and their performance and issues its own purchase orders. Corporate purchasing maintains this database and uses it to negotiate contracts for the corporation and to monitor the units. The payoffs have come in a 150% improvement in on-time deliveries, 50% reduction in lead times, 75% reduction in failure rates, and a significantly lower cost of goods purchased.

Link parallel activities instead of integrating their results. H-P's decentralized purchasing operations represent one kind of parallel processing in which separate units perform the same function. Another common kind of parallel processing is when separate units perform different activities that must eventually come together. Product development typically operates this way. In the development of a photo copier, for example, independent units develop th

various subsystems of the copier. One group works on the optics, another on the mechanical paper-handling device, another on the power supply, and so on. Having people do development work simultaneously saves time, but at the dreaded integration and testing phase, the pieces often fail to work together. Then the costly redesign begins.

Or consider a bank that sells different kinds of credit–loans, letters of credit, asset-based financing–through separate units. These groups may have no way of knowing whether another group has already extended credit to a particular customer. Each unit could extend the full $10 million credit limit.

> Coordinate parallel functions *during* the process–not after it's completed.

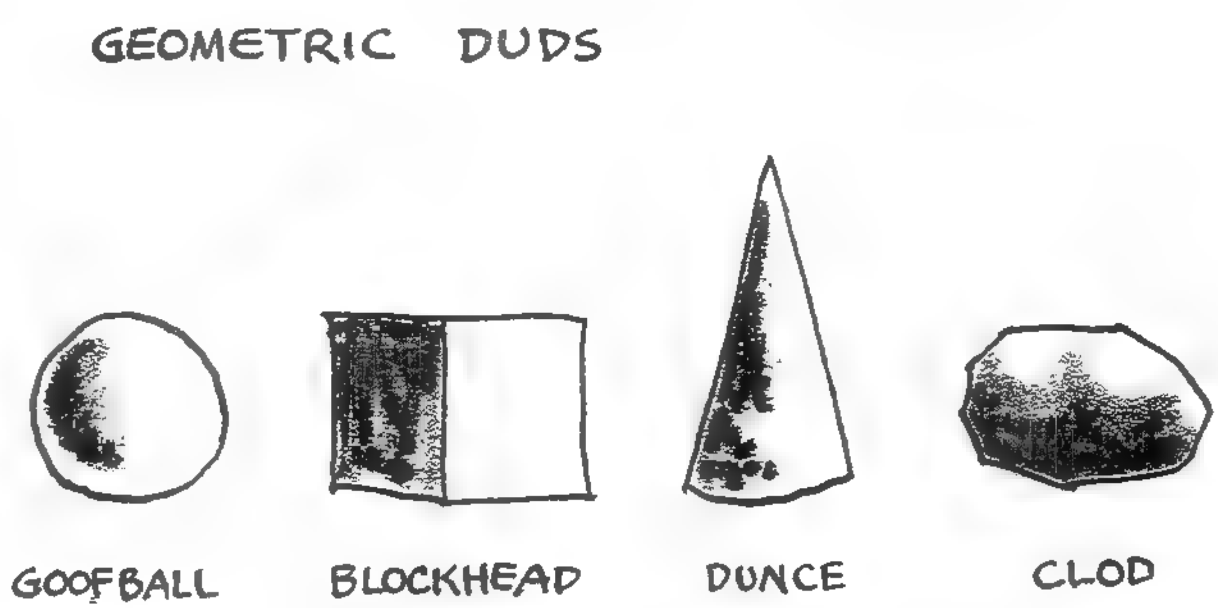
The new principle says to forge links between parallel functions and to coordinate them while their activities are in process rather than after they are completed. Communications networks, shared databases, and teleconferencing can bring the independent groups together so that coordination is ongoing. One large electronics company has cut its product development cycle by more than 50% by implementing this principle.

Put the decision point where the work is performed, and build control into the process. In most organizations, those who do the work are distinguished from those who monitor the work and make decisions about it. The tacit assumption is that the people actually doing the work have neither the time nor the inclination to monitor and control it and that they lack the knowledge and scope to make decisions about it. The entire hierarchical management structure is built on this assumption. Accountants, auditors, and supervisors check, record, and monitor work. Managers handle any exceptions.

The new principle suggests that the people who do the work should make the decisions and that the process itself can have built-in controls. Pyramidal management layers can therefore be compressed and the organization flattened.

Information technology can capture and process data, and expert systems can to some extent supply knowledge, enabling people to make their own decisions. As the doers become self-managing and self-controlling, hierarchy–and the slowness and bureaucracy associated with it–disappears.

When Mutual Benefit Life reengineered the insurance application process, it not only compressed the linear sequence but also eliminated the need for lay-



CARTOON BY H. MARTIN

ers of managers. These two kinds of compression–vertical and horizontal–often go together; the very fact that a worker sees only one piece of the process calls for a manager with a broader vision. The case managers at MBL provide end-to-end management of the process, reducing the need for traditional managers. The managerial role is changing from one of controller and supervisor to one of supporter and facilitator.

Capture information once and at the source. This last rule is simple. When information was difficult to transmit, it made sense to collect information repeatedly. Each person, department, or unit had its own requirements and forms. Companies simply had to live with the associated delays, entry errors, and costly overhead. But why do we have to live with those problems now? Today when we collect a piece of information, we can store it in an on-line database for all who need it. Bar coding, relational databases, and electronic data interchange (EDI) make it easy to collect, store, and transmit information. One insurance company found that its application review process required that certain items be entered into "stovepipe" computer systems supporting different functions as many as five times. By integrating and connecting these systems, the company was able to eliminate this redundant data entry along with the attendant checking functions and inevitable errors.

Think Big

Reengineering triggers changes of many kinds, not just of the business process itself. Job designs, organizational structures, management systems–anything associated with the process–must be refashioned in an integrated way. In other words, reengineering is a tremendous effort that mandates change in many areas of the organization.

When Ford reengineered its payables, receiving clerks on the dock had to learn to use computer terminals to check shipments, and they had to make decisions about whether to accept the goods. Purchasing agents also had to assume new responsibilities–like making sure the purchase orders they entered into the database had the correct information about where to send the check. Attitudes toward vendors also had to change: vendors could no longer be seen as adversaries; they had to become partners in a shared business process. Vendors too had to adjust. In many cases, invoices formed the basis of their accounting systems. At least one Ford supplier adapted by continuing to print invoices, but instead of sending them to Ford threw them away, reconciling cash received against invoices never sent.

The changes at Mutual Benefit Life were also widespread. The company's job-rating scheme could not accommodate the case manager position, which had a lot of responsibility but no direct reports. MBL had to devise new job-rating schemes and compensation policies. It also had to develop a culture in which people doing work are perceived as more important than those supervising work. Career paths, recruitment and training programs, promotion policies–these and many other management systems are being revised to support the new process design.

The extent of these changes suggests one factor that is necessary for reengineering to succeed: executive leadership with real vision. No one in an organization wants reengineering. It is confusing and disruptive and affects everything people have grown accustomed to. Only if top-level managers back the effort and outlast the company cynics will people take reengineering seriously. As one wag at an electronics equipment manufacturer has commented, "Every few months, our senior managers find a new religion. One time it was quality, another it was customer service, another it was flattening the organization. We just hold our breath until they get over it and things get back to normal." Commitment, consistency–maybe even a touch of fanaticism–are needed to enlist those who would prefer the status quo.

Considering the inertia of old processes and structures, the strain of implementing a reengineering plan can hardly be overestimated. But by the same token, it is hard to overestimate the opportunities, especially for established companies. Big, traditional organizations aren't necessarily dinosaurs doomed to extinction, but they are burdened with layers of unproductive overhead and armies of unproductive workers. Shedding them a layer at a time will not be good enough to stand up against sleek startups or streamlined Japanese companies. U.S. companies need fast change and dramatic improvements.

We have the tools to do what we need to do. Information technology offers many options for reorganizing work. But our imaginations must guide our decisions about technology–not the other way around. We must have the boldness to imagine taking 78 days out of an 80-day turnaround time, cutting 75% of overhead, and eliminating 80% of errors. These are not unrealistic goals. If managers have the vision, reengineering will provide a way.

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The New Industrial Engineering: Information Technology and Business Process Redesign

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THOSE ASPIRING TO IMPROVE the way work is done must begin to apply the capabilities of information technology to redesign business processes. Business process design and information technology are natural partners, yet industrial engineers have never fully exploited their relationship. The authors argue, in fact, that it has barely been exploited at all. But the organizations that *have* used IT to redesign boundary-crossing, customer-driven processes have benefited enormously. This article explains why.

AT THE TURN of the century, Frederick Taylor revolutionized the workplace with his ideas on work organization, task decomposition, and job measurement. Taylor's basic aim was to increase organizational productivity by applying to human labor the same engineering principles that had proven so successful in solving the technical problems in the work environment. The same approaches that had transformed mechanical activity could also be used to structure jobs performed by people. Taylor came to symbolize the practical realizations in industry that we now call industrial engineering (IE), or the scientific school of management.[1] In fact, though work design remains a contemporary IE concern, no subsequent concept or tool has rivaled the power of Taylor's mechanizing vision.

As we enter the 1990s, however, two newer tools are transforming organizations to the degree that Taylorism once did. These are *information technology*—the capabilities offered by computers, software applications, and telecommunications—and *business process redesign*—the analysis and design of work flows and processes within and between organizations. Working together, these tools have the potential to create a new type of industrial engineering, changing the way the discipline is practiced and the skills necessary to practice it.

This article explores the relationship between information technology (IT) and business process redesign (BPR). We report on research conducted at MIT, Harvard, and several consulting organizations on nineteen companies, including detailed studies of five firms engaged in substantial process redesign. After defining business processes, we extract from the experience of the companies studied a generic five-step approach to redesigning processes with IT. We then define the major types of processes, along with the primary role of IT in each type of process. Finally, we consider management issues that arise when IT is used to redesign business processes.

IT in Business Process Redesign

The importance of both information technology and business process redesign is well known to industrial engineers, albeit as largely separate tools for use in specific, limited environments.[2] IT is used in industrial engineering as an analysis and modeling tool, and IEs have often taken the lead in applying information technology to manufacturing environments. Well-known uses of IT in manufacturing include process modeling, production scheduling and control, materials management information systems, and logistics. In most cases where IT has been used to redesign work, the redesign has most likely been in the manufacturing function, and industrial engineers are the most likely individuals to have carried it out.

IEs have begun to analyze work activities in nonmanufacturing environments, but their penetration into offices has been far less than in factories. IT has certainly penetrated the office and services environments—in 1987 *Business Week* reported that almost 40 percent of all U.S. capital spending went

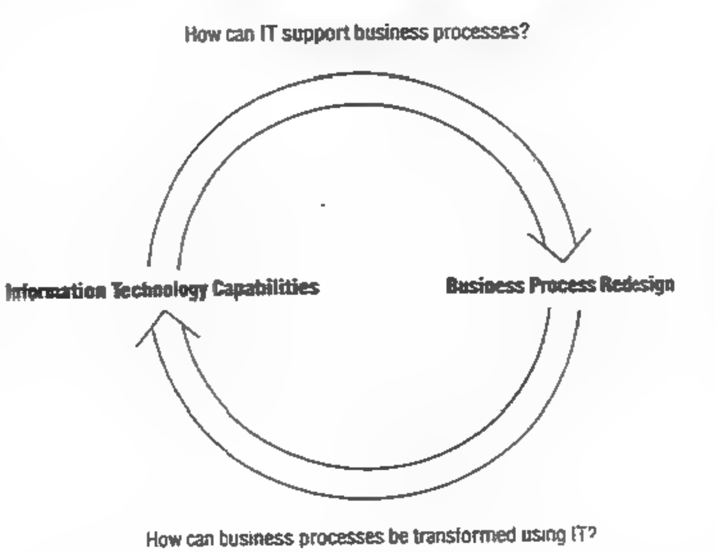
to information systems, some $97 billion a year—but IT has been used in most cases to hasten office work rather than to transform it.[3] With few exceptions, IT's role in the redesign of nonmanufacturing work has been disappointing; few firms have achieved major productivity gains.[4] Aggregate productivity figures for the United States have shown no increase since 1973.[5]

Given the growing dominance of service industries and office work in the Western economies, this type of work is as much in need of analysis and redesign as the manufacturing environments to which IT has already been applied. Many firms have found that this analysis requires taking a broader view of both IT and business activity, and of the relationships between them. Information technology should be viewed as more than an automating or mechanizing force; it can fundamentally reshape the way business is done. Business activities should be viewed as more than a collection of individual or even functional tasks; they should be broken down into processes that can be designed for maximum effectiveness, in both manufacturing and service environments.

Our research suggests that IT can be more than a useful tool in business process redesign. In leading edge practice, information technology and BPR have a recursive relationship, as Figure 1 illustrates Each is the key to thinking about the other. Thinking about information technology should be in terms of how it supports new or redesigned business processes, rather than business functions or other organizational entities. And business processes and process improvements should be considered in terms of the capabilities information technology can provide. *We refer to this broadened, recursive view of IT and BPR as the new industrial engineering*

Taylor could focus on workplace rationalization and individual task efficiency because he confronted a largely stable business environment; today's corporations do not have the luxury of such stability.[6] Individual tasks and jobs change faster than they can be redesigned. Today, responsibility for an outcome is more often spread over a group, rather than assigned to an individual as in the past. Companies increasingly find it necessary to develop more flexible, team-oriented, coordinative, and communication-based work capability. In short, rather than maximizing the performance of particular individuals or business functions, companies must maximize interdependent activities within and across the entire organization. Such business processes are a new approach to coordination across the firm; information technology's promise—and perhaps its ultimate impact—is to be the most powerful tool in the twentieth century for reducing the costs of this coordination.[7]

Figure 1 **The Recursive Relationship between IT Capabilities and Business Process Redesign**



What Are Business Processes?

We define business processes as a set of logically related tasks performed to achieve a defined business outcome. This definition is similar to Pall's: "The logical organization of people, materials, energy, equipment, and procedures into work activities designed to produce a specified end result (work product)."[8]

A set of processes forms a business system—the way in which a business unit, or a collection of units, carries out its business. Processes have two important characteristics:

- They have customers; that is, processes have defined business outcomes, and there are recipients of the outcomes. Customers may be either internal or external to the firm.
- They cross organizational boundaries; that is, they normally occur across or between organizational subunits. Processes are generally indepen-

dent of formal organizational structure.

Common examples of processes meeting these criteria include

- developing a new product;
- ordering goods from a supplier,
- creating a marketing plan;
- processing and paying an insurance claim; and
- writing a proposal for a government contract.

Ordering goods from a supplier, for example, typically involves multiple organizations and functions. The end user, purchasing, receiving, accounts payable, etc., and the supplier organization are all participants. The user could be viewed as the process's customer. The process outcome could be either the creation of the order, or, perhaps more usefully, the actual receipt of the goods by the user.

Our examples so far are of large-scale processes that affect whole organizations or groups. There are more detailed processes that meet the definitional criteria above. These might include installing a windshield in an automobile factory, or completing a monthly departmental expense report. IT-driven process redesign can be applied to these processes, but the implications of redesigning them may be important only in the aggregate. In many of the firms studied, analyzing processes in great detail was highly appropriate for some purposes, for example, the detailed design of an information system or data model to support a specific work process. However, the firms that were truly beginning to redesign their business functions took a broader view of processes.

A Brief History of Process Thinking

Process thinking has become widespread in recent years, due largely to the quality movement. Industrial engineers and others who wish to improve the quality of operations are urged to look at an entire process, rather than a particular task or business function. At IBM, for example, "process management will be the principal IBM quality focus in the coming years."[9] But process discussions in the quality movement's literature rarely mention information technology. Rather, the focus is usually on improving process control systems in a manufacturing context; when IT is discussed, it is in the context of factory floor automation. Recent IE literature also borders on process thinking when advocating cross-functional analysis,[10] although, as we will discuss, cross-functional processes are only one possible type of process.

Other than quality-oriented manufacturing process redesign, most processes in major corporations have not been subject to rigorous analysis and redesign. Indeed, many of our current processes result from a series of ad hoc decisions made by functional units, with little attention to effectiveness across the entire process. Many processes have never even been measured. In one manufacturing company studied, for example, no one had ever analyzed the elapsed time from a customer's order to delivery. Each department (sales, credit checking, shipping, and so on) felt that it had optimized its own performance, but in fact the overall process was quite lengthy and unwieldy.

Even fewer business processes have been analyzed with the capabilities of IT in mind. Most business processes were developed before modern computers and communications even existed. When technology has been applied, it is usually to automate or speed up isolated components of an existing process. This creates communication problems within processes and impediments to process redesign and enhancement. For example, in a second manufacturing firm studied, the procurement process involved a vendor database, a materials management planning system, and accounts payable and receivable systems, all running on different hardware platforms with different data structures. Again, each organizational subunit within the process had optimized its own IT application, but no single subunit had looked at (or was responsible for) the entire process. We believe the problems this firm experienced are very common.

Redesigning Business Processes with IT: Five Steps

Assuming that a company has decided its processes are inefficient or ineffective, and therefore in need of redesign, how should it proceed? This is a straightforward activity, but five major steps are involved: develop the business vision and process objectives, identify the processes to be redesigned, understand and measure the existing process, identify IT levers, and design and build a prototype of the new process (see Figure 2). We observed most or all of these steps being performed in companies that were succeeding with BPR. Each step is described in greater detail below.

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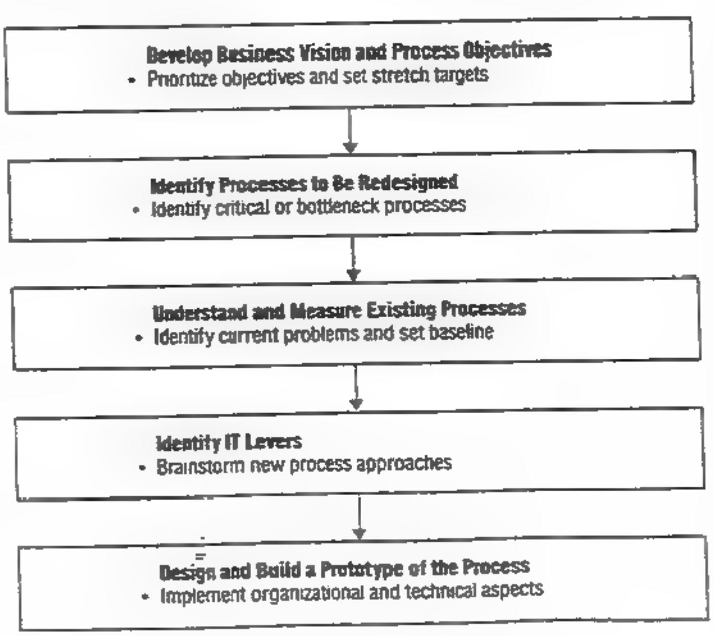
Develop Business Vision and Process Objectives

In the past, process redesign was typically intended simply to "rationalize" the process, in other words, to eliminate obvious bottlenecks and inefficiencies. It did not involve any particular business vision or context. This was the approach of the "work simplification" aspect of industrial engineering, an important legacy of Taylorism. An example of the rationalization approach appears in a 1961 "Reference Note on Work Simplification" from the Harvard Business School:

> A good manager asks himself *why* things are done as they are, extending his inquiry to every aspect of the job and the surroundings in which it is performed, from the flow of paper work to the daily functioning of his subordinates. . . . He is expected to supply the stimulus and show that job improvement or simplification of work is not only important but also is based on common-sense questioning aimed at uncovering the easiest, most economical way of performing a job.[11]

Our research suggests strongly that rationalization is not an end in itself, and is thus insufficient as a process redesign objective. Furthermore, rationalization of highly decomposed tasks may lead to a less efficient overall process. Instead of task rationalization, redesign of entire processes should be undertaken with a specific business vision and related objectives in mind.

Figure 2 Five Steps in Process Redesign



In most successful redesign examples we studied, the company's senior management had developed a broad strategic vision into which the process redesign activity fit.[12] At Xerox, for example, this vision involved taking the perspective of the customer and developing systems rather than stand-alone products; both required cross-functional integration. At Westinghouse, the vision consisted largely of improving product quality. Ford's involved adopting the best practices of Japanese automobile manufacturers, including those of Mazda, of which it is a partial owner.

Each of these visions implied specific objectives for process redesign. The most likely objectives are the following:

• **Cost Reduction.** This objective was implicit in the "rationalization" approach. Cost is an important redesign objective in combination with others, but insufficient in itself. Excessive attention to cost reduction results in tradeoffs that are usually unacceptable to process stakeholders. While optimizing on other objectives seems to bring costs into line, optimizing on cost rarely brings about other objectives.

• **Time Reduction.** Time reduction has been only a secondary objective of traditional industrial engineering. Increasing numbers of companies, however, are beginning to compete on the basis of time.[13] Processes, as we have defined them, are the ideal unit for a focused time reduction analysis. One common approach to cutting time from product design is to make the steps begin simultaneously, rather than sequentially, using IT to coordinate design directions among the various functional participants. This approach has been taken in the design of computers, telephone equipment, automobiles, and copiers (by Digital Equipment, AT&T Bell Labs, Ford, and Xerox, respectively).

• **Output Quality.** All processes have outputs, be they physical—such as in manufacturing a tangible product—or informational—such as in adding data to a customer file. Output quality is frequently the focus of process improvement in manufacturing environments; it is just as important in service industries. The specific measure of output quality may be uniformity, variability, or freedom from defects; this should be defined by the customer of the process.

• **Quality of Worklife (QWL)/Learning/Em-

powerment. IT can lead either to greater empowerment of individuals, or to greater control over their output. Zuboff points out that IT-intensive processes are often simply automated, and that the "informating" or learning potential of IT in processes is often ignored.[14] Moreover, Schein notes that organizations often do not provide a supportive context for individuals to introduce or innovate with IT.[15] Of course, it is rarely possible to optimize all objectives simultaneously, and in most firms, the strongest pressures are to produce tangible benefits. Yet managers who ignore this dimension risk failure of redesigned processes for organizational and motivational factors.

Some firms have been able to achieve multiple objectives in redesigning processes with IT. American Express, for example, set out to improve the cost, time, and quality of its credit authorization process by embedding the knowledge of its best authorizers in an "Authorizer's Assistant" expert system. This successful redesign led to a $7 million annual reduction in costs due to credit losses, a 25 percent reduction in the average time for each authorization, and a 30 percent reduction in improper credit denials.

Finally, all firms found it was important to set specific objectives, even to the point of quantification. Though it is difficult to know how much improvement is possible in advance of a redesign, "reach should exceed grasp." Setting goals that will stretch the organization will also provide inspiration and stimulate creative thinking. For example, a company might decide to reduce the time to bring new products to market by 80 percent. In the accounts payable process at Ford, the "stretch" goal was to eliminate invoices—to pay suppliers upon receipt of their products or services. This goal has been achieved with help from an information system to confirm expected deliveries at the loading dock. As a result, Ford has eliminated three-quarters of the jobs in accounts payable.

Identify Processes to Be Redesigned

Most organizations could benefit from IT-enabled redesign of critical (if not *all*) business processes. However, the amount of effort involved creates practical limitations. Even when total redesign was the ultimate objective, the companies we studied selected a few key processes for initial efforts. Moreover, when there was insufficient commitment to total redesign, a few successful examples of IT-enhanced processes became a powerful selling tool.

The means by which processes to be redesigned are identified and prioritized is a key issue. This is often difficult because most managers do not think about their business operations in terms of processes. There are two major approaches. The *exhaustive* approach attempts to identify all processes within an organization and then prioritize them in order of redesign urgency. The *high-impact* approach attempts to identify only the most important processes or those most in conflict with the business vision and process objectives.

The exhaustive approach is often associated with "information engineering" (developed by James Martin in the early 1980s), in which an organization's use of data dictates the processes to be redesigned.[16] For example, one information engineering method, employed at several divisions of Xerox, involves identifying business activities and the data they require using a data-activity matrix. The clusters of data activity interactions in the cells of the matrix are the organization's major business processes. Once processes are identified, Xerox managers prioritize them in the order in which new IT applications support should be provided. Although process identification in some Xerox divisions has taken as little as three months, many companies find this approach very time consuming.

The alternative is to focus quickly on high-impact processes. Most organizations have some sense of which business areas or processes are most crucial to their success, and those most "broken" or inconsistent with the business vision. If not, these can normally be identified using senior management workshops, or through extensive interviewing.[17] At IBM, the salesforce was surveyed to determine the relative importance of various customer support processes; the generation of special bids emerged as the highest priority and was the first process to be redesigned.

Companies that employed the high-impact approach generally considered it sufficient. Companies taking the exhaustive approach, on the other hand, have not had the resources to address all the identified processes; why identify them if they cannot be addressed? As a rough rule of thumb, most companies we studied were unable to redesign and support more than ten to fifteen major processes per year (i.e., one to three per major business unit); there was simply not enough management attention to do more. And some organizations have

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abandoned the exhaustive approach.[18]

Whichever approach is used, companies have found it useful to classify each redesigned process in terms of beginning and end points, interfaces. and organization units (functions or departments) involved, particularly including the customer unit. Thinking in these terms usually broadens the perceived scope of the process. For example, a sales manager may be aware that there are inefficiencies in customer order entry. A skilled process consultant might decide that the whole process—negotiating, receiving, and fulfilling orders—needs to be redesigned. Whether the problem is broken down into three processes or viewed as one is not important; expanding the *scope* of the process analysis is the key issue.

High-impact processes should also have owners.[19] In virtually all the process redesigns we studied, an important step was getting owners to buy in to both the idea and the scope of process redesign at an early stage. In several companies, managers felt that the process owner's job should be either above the level of the functions and units involved, or, if on the same level, that the owner should be willing—and able—to change the status quo. The difficulty, however, is that some processes only come together at the CEO level. In this situation, the CEO should designate a senior manager as owner and invest him or her with full authority. Processes that are fully contained within a single function or department can normally be owned by the manager of that area.

Understand and Measure Existing Processes

There are two primary reasons for understanding and measuring processes before redesigning them. First, problems must be understood so that they are not repeated. Second, accurate measurement can serve as a baseline for future improvements. If the objective is to cut time and cost, the time and cost consumed by the untouched process must be measured accurately. Westinghouse Productivity and Quality Center consultants found that simply graphing the incremental cost and time consumed by process tasks can often suggest initial areas for redesign. These graphs look like "step functions" showing the incremental contribution of each major task.

This step can easily be overemphasized, however. In several firms, the "stretch" goal was less to eliminate problems or bottlenecks than to create radical improvements. Designers should be informed by past process problems and errors, but they should work with a clean slate. Similarly, the process should not be measured for measurement's sake. Only the specific objectives of the redesign should be measured. As with the high-impact process identification approach, an 80-20 philosophy is usually appropriate.

Identify IT Levers

Until recently, even the most sophisticated industrial engineering approaches did not consider IT capabilities until after a process had been designed. The conventional wisdom in IT usage has always been to first determine the business requirements of a function, process, or other business entity, and then to develop a system. The problem is that an awareness of IT capabilities can—and should—influence process design. Knowing that product development teams can exchange computer-aided designs over large distances, for example, might affect the structure of a product development process. The role of IT in a process should be considered in the early stages of its redesign.[20]

Several firms accomplished this using brainstorming sessions, with the process redesign objectives and existing process measures in hand. It was also useful to have a list of IT's generic capabilities in improving business processes. In the broadest sense, *all* of IT's capabilities involve improving coordination and information access across organizational units, thereby allowing for more effective management of task interdependence. More specifically, however, it is useful to think about IT capabilities and their organizational impacts in eight different ways (see Table 1).

There are undoubtedly other important IT capabilities that can reshape processes. Organizations may want to develop their own lists of capabilities that are specific to the types of processes they employ. The point is twofold: IT is so powerful a tool that it deserves its own step in process redesign, and IT can actually create new process design options, rather than simply support them.

Design and Build a Prototype of the Process

For most firms, the final step is to design the process. This is usually done by the same team that

performed the previous steps, getting input from constituencies and using brainstorming workshops. A key point is that the actual design is not the end of the process. Rather, it should be viewed as a prototype, with successive iterations expected and managed. Key factors and tactics to consider in process design and prototype creation include using IT as a design tool, understanding generic design criteria, and creating organizational prototypes.

• IT as a Design Tool. Designing a business process is largely a matter of diligence and creativity. Emerging IT technologies, however, are beginning to facilitate the "process" of process design. Some computer-aided systems engineering (CASE) products are designed primarily to draw process models. The ability to draw models rapidly and make changes suggested by process owners speeds redesign and facilitates owner buy-in. Some CASE products can actually generate computer code for the information systems application that will support a modeled business process.

Several Xerox divisions, for example, are moving directly from process modeling to automated generation of computer code for high-priority processes. They report improved productivity and high user satisfaction with the resulting systems. A further benefit is that when the business process changes, the IS organization can rapidly modify the affected system. Use of code generation products generally presumes that process designers will use the exhaustive approach to process identification.

• Generic Design Criteria. Companies used various criteria for evaluating alternative designs. Most important, of course, is the likelihood that a design will satisfy the chosen design objectives. Others mentioned in interviews included the simplicity of the design, the lack of buffers or intermediaries, the degree of control by a single individual or department (or an effective, decentralized coordinative mechanism), the balance of process resources, and the generalization of process tasks (so that they can be performed by more than one person).

• Organizational Prototypes. Mutual Benefit Life's (MBL) redesign of its individual life insurance underwriting process illustrates a final, important point about process design. At MBL, underwriting a life insurance policy involved 40 steps with over 100 people in 12 functional areas and 80 separate jobs. To streamline this lengthy and complex process, MBL undertook a pilot project with the goal of improving productivity by 40 percent. To integrate the process, MBL created a new role, the case manager. This role was designed to perform and coordinate all underwriting tasks centrally, utilizing a workstation-based computer system capable of pulling data from all over the company. After a brief start-up period, the firm learned that two additional roles were necessary on some underwriting cases: specialists such as lawyers or medical directors in knowledge-intensive fields, and clerical assistance. With the new role and redesigned process, senior managers at MBL are confident of reaching the 40 percent goal in a few months. This example illustrates the value of creating organizational prototypes in IT-driven process redesign.

Creating prototypes of IT applications has already gained widespread acceptance. Advocates argue that building a prototype of an IT change usually achieves results faster than conventional "life cycle" development, and, more important, that the result is much more likely to satisfy the customer. Building prototypes of business process changes and organizational redesign initiatives can yield similar benefits.[21] The implications of this extension are that process designs, after agreement by owners and stakeholders, would be implemented on a pilot basis (perhaps in parallel with existing processes), examined regularly for problems and objective achievement, and modified as necessary. As the process approached final acceptance, it would be phased into full implementation.

Table 1 IT Capabilities and Their Organizational Impacts

Capability	Organizational Impact/Benefit
Transactional	IT can transform unstructured processes into routinized transactions
Geographical	IT can transfer information with rapidity and ease across large distances, making processes independent of geography
Automational	IT can replace or reduce human labor in a process
Analytical	IT can bring complex analytical methods to bear on a process
Informational	IT can bring vast amounts of detailed information into a process
Sequential	IT can enable changes in the sequence of tasks in a process, often allowing multiple tasks to be worked on simultaneously
Knowledge Management	IT allows the capture and dissemination of knowledge and expertise to improve the process
Tracking	IT allows the detailed tracking of task status, inputs, and outputs
Disintermediation	IT can be used to connect two parties within a process that would otherwise communicate through an intermediary (internal or external)

Figure 3	Types of Processes	
Process Dimension and Type	**Typical Example**	**Typical IT Role**
Entities		
Interorganizational	Order from a supplier	Lower transaction costs; eliminate intermediaries
Interfunctional	Develop a new product	Work across geography; greater simultaneity
Interpersonal	Approve a bank loan	Role and task integration
Objects		
Physical	Manufacture a product	Increased outcome flexibility; process control
Informational	Create a proposal	Routinizing complex decisions
Activities		
Operational	Fill a customer order	Reduce time and costs; increase output quality
Managerial	Develop a budget	Improve analysis; increase participation

Defining Process Types

The five steps described above are sufficiently general to apply to most organizations and processes. Yet the specifics of redesign vary considerably according to the type of process under examination. Different types require different levels of management attention and ownership, need different forms of IT support, and have different business consequences. In this section, we present three different dimensions within which processes vary.

Understanding and classifying the different types of processes is important because an organization can appear to be a seamless web of interconnected processes. With various process *types* in mind, a manager can begin to isolate particular processes for analysis and redesign, including activities that, without process thinking, might otherwise be overlooked.

Three major dimensions can be used to define processes (see Figure 3). These are the organizational entities or subunits involved in the process, the type of objects manipulated, and the type of activities taking place. We describe each dimension and resulting process type below.

Defining Process Entities

Processes take place between types of organizational entities. Each type has different implications for IT benefits.

Interorganizational processes are those taking place between two or more business organizations. Increasingly, companies are concerned with coordinating activities that extend into the next (or previous) company along the value-added chain. Several U.S. retail, apparel, and textile companies, for example, have linked their business processes to speed up reordering of apparel. When Dillard's (department store) inventory of a particular pants style falls below a specified level, Haggar (apparel manufacturer) is notified electronically. If Haggar does not have the cloth to manufacture the pants, Burlington Industries (textile manufacturer) is notified electronically. As this example of electronic data interchange (EDI) illustrates, information technology is the major vehicle by which this interorganizational linkage is executed.

For most companies, simple market relationships are the most common source of interorganizational processes. All the tasks involved in a selling-buying transaction form a critical process for sellers, and an increasingly important one for buyers seeking higher quality, cost efficiency, and responsiveness. Yet much of the focus has been on a simple transaction level, rather than on an interorganizational business process level. Again, how EDI is used illustrates this point.

Buyers and sellers have used EDI largely to speed up routine purchasing transactions, such as invoices or bills of materials. Few companies have attempted to redesign the broader procurement process—from the awareness that a product is needed, to the development of approved vendor lists, or even to the delivery and use of the purchased product. In the future, sellers will need to look at all buyer processes in which their products are involved.

Moreover, many firms will need to help the buyer improve those processes. Du Pont's concept of "effectiveness in use" as the major criterion of customer satisfaction is one leading approach to measuring the effectiveness of interorganizational processes. Du Pont is motivated not simply to sell a product, but to link its internal processes for creating value in a product, to its customer's processes for using the product. This concept led Du Pont to furnish EDI-provided Material Safety Data Sheets along with the chemicals it sells to its customers

to ensure their safe use.

Westinghouse used an interorganizational process approach in dealing with Portland General Electric (PGE), a major customer of power generation equipment. PGE managers called upon Westinghouse's Productivity and Quality Center, a national leader in process improvement, to help them implement EDI, but the Westinghouse team asked if it could analyze the entire process by which PGE procured equipment from Westinghouse and other suppliers. They found that, while implementing EDI could yield efficiencies on the order of 10 percent, changing the overall procurement process, including using EDI and bypassing the purchasing department altogether for most routine purchase orders, could lead to much greater savings. In one case, the time to execute a standard purchase order, for example, could be reduced from fifteen days to half a day; the cost could be reduced from almost $90 to $10.

A second major type of business process is *interfunctional*. These processes exist within the organization, but cross several functional or divisional boundaries. Interfunctional processes achieve major operational objectives, such as new product realization, asset management, or production scheduling. Most management processes—for example, planning, budgeting, and human resource management—are interfunctional.

Many manufacturing companies that focused on quality improvement found that producing quality products and services required addressing difficult interfunctional issues. Yet most firms have never even listed their key interfunctional processes, let alone analyzed or redesigned them, with or without the aid of IT.

Two companies that recently analyzed their key interfunctional business processes are Baxter Healthcare Corporation and US Sprint Communications Company. Baxter's 1985 merger with American Hospital Supply provided the context for a major analysis of key business strategies, and the alignment of the IT infrastructure with those strategies.[23] As part of a seven-month IT planning effort, the company defined twenty-nine major interfunctional processes and analyzed the current and future role of IT in supporting them. For example, in the distribution area, the company identified order entry, inventory, warehouse management, purchasing, transportation, and equipment tracking as key processes. The success of this IT planning effort led Baxter to incorporate the process definition approach into its annual corporate planning process.

At US Sprint, well-publicized problems with the customer billing system prompted the company's IT function to develop a model of information flows for the entire business as part of a comprehensive systems improvement program. This model defined the critical information and key interfunctional processes necessary to run the business. Sprint is now assigning ownership to key processes and continuing to identify improvements—and ways to measure them—in each process. The systems improvement program raised the IT organization's composite internal quality index by more than 50 percent in one year.[24]

A major problem in redesigning interfunctional processes is that most information systems of the past were built to automate specific functional areas or parts of functions. Few third-party application software packages have been developed to support a full business process. Very few organizations have modeled existing interfunctional processes or redesigned them, and companies will run into substantial problems in building interfunctional systems without such models.

Interpersonal processes involve tasks within and across small work groups, typically within a function or department. Examples include a commercial loan group approving a loan, or an airline flight crew preparing for takeoff. This type of process is becoming more important as companies shift to self-managing teams as the lowest unit of organization. Information technology is increasingly capable of supporting interpersonal processes; hardware and communications companies have developed new networking-oriented products, and software companies have begun to flesh out the concept of "groupware" (e.g., local area network-based mail, conferencing, and brainstorming tools).[25]

Several companies, including GM's Electronic Data Systems (EDS), are exploring tools to facilitate the effectiveness of meetings and small group interactions. At EDS, the primary focus is on enhancing the interpersonal processes involved in automobile product development. The company's Center for Machine Intelligence has developed a computer-supported meeting room, and is studying its implications for group decision making and cooperative work.[26]

We should point out that IT can make it possible for employees scattered around the world to work as a team. As an example, Ford now creates

new car designs using teams that have members in Europe, Central America, and the United States Because Ford has standardized computer-aided design systems and created common data structures for the design process, engineers can share complex three-dimensional designs across the Atlantic. Similarly, a small team at Digital Equipment used the company's electronic mail and conferencing capabilities to build the core of a new systems integration business. The team was scattered around the United States and Europe and only rarely met in person.

Defining Process Objects

Processes can also be categorized by the types of objects manipulated. The two primary object types are physical and informational. In physical object processes, real, tangible things are either created or manipulated; manufacturing is the obvious example. Informational object processes create or manipulate information. Processes for making a decision, preparing a marketing plan, or designing a new product are examples.

Many processes involve the combination of physical and informational objects. Indeed, adding information to a physical object as it moves through a process is a common way of adding value. Most logistical activities, for example, combine the movement of physical objects with the manipulation of information concerning their whereabouts. Success in the logistics industry is often dependent on the close integration of physical and informational outcomes; both UPS and Federal Express, for example, track package movement closely.

The potential for using IT to improve physical processes is well known. It allows greater flexibility and variety of outcomes, more precise control of the process itself, reductions in throughput time, and elimination of human labor. These benefits have been pursued for the past three decades. Still, manufacturing process flows are often the result of historical circumstance and should usually be redesigned before further automation is applied. This is particularly true in low volume, job shop manufacturing environments.[27] Redesigners of physical processes should also consider the role of IT in providing information to improve processes; Shoshana Zuboff has described this "informating" effect in detail for the paper industry.[28]

Strangely, the proportion of informational processes already transformed by IT is probably lower than that of physical processes. True, legions of clerks have become unemployed because of computers. But the majority of information processes to which IT has been applied are those involving high volume and low complexity. Now that these processes are well known even if not fully conquered, the emphasis needs to shift to processes that incorporate semistructured and unstructured tasks and are performed by high-skill knowledge workers. Relevant IT capabilities include the storage and retrieval of unstructured and multimedia information, the capturing and routinizing of decision logic, and the application of far-flung and complex data resources. A computer vendor's advertising videotape, for example, illustrates how artificial intelligence and "hypertext," or mixed-media databases, combine to lead a manager through the process of developing a departmental budget. The IT capabilities in the video are available today, but they are rarely applied to such information-intensive yet unstructured processes.

Defining Process Activities

Our examples of business processes have involved two types of activities: operational and managerial. Operational processes involve the day-to-day carrying out of the organization's basic business purpose. Managerial processes help to control, plan, or provide resources for operational processes. Past uses of IT to improve processes, limited as they are, have been largely operational. We will therefore focus almost entirely on managerial processes in this section.[29]

Applying IT to management *tasks* is not a new idea. The potential of decision support systems, executive support systems, and other managerial tools has been discussed for over twenty years. We believe, however, that the benefits have not been realized because of the absence of systematic process thinking. Few companies have rigorously analyzed managerial activities as processes subject to redesign. Even the notion of managerial activities involving defined outcomes (a central aspect of our definition of business processes) is somewhat foreign. How would such managerial processes as deciding on an acquisition or developing the agenda for the quarterly board meeting be improved if they were treated as processes—in other words, measured, brainstormed, and redesigned with IT capabilities?

The generic capabilities of IT for reshaping

IT-Driven Process Redesign at Rank Xerox U.K.

Rank Xerox U.K. (RXUK), a national operating company of Xerox Corporation, has undertaken the most comprehensive IT-driven process redesign we have studied. The process was led by David O'Brien, the division's managing director, who arrived at the company in 1985. O'Brien quickly came to two realizations: first, the company needed to focus on marketing "office systems" in addition to its traditional reprographics products; and second, the company's strong functional culture and inefficient business processes would greatly inhibit its growth. He began to see his own organization as a place to test integrated office systems that support integrated business processes; if successful, he could use RXUK as a model for customers.

The company began to redesign its business in 1987. In a series of offsite meetings, the senior management team reappraised its external environment and mission, then identified the key business processes needed if the company was to achieve its mission. The group began to restructure the organization around cross-functional processes, identifying high-level objectives and creating task forces to define information and other resource requirements for each process. It created career systems revolving around facilitation skills and cross-functional management, rather than hierarchical authority. O'Brien decided to keep a somewhat functional formal structure, because functional skills would still be needed in a process organization and because the level of organizational change might have been too great with a wholly new structure.

The level of change was still very high. Several senior managers departed because they could not or would not manage in the new environment. Two new cross-functional senior positions, called "facilitating directors," were created, one for organizational and business development, the other for process management, information systems, and quality. O'Brien took great advantage of the honeymoon period accorded to new CEOs, but managing the change still required intense personal attention:

> Of course, this new thinking was in sharp contrast to some of the skills and attitudes of the company. We were introducing a change in management philosophy in a company that, in many ways, was very skillful and effective, but in a different product-market environment. We faced all the issues of attitudinal change and retraining that any such change implies. We were moving to a much more integrated view of the world and had to encourage a major shift in many patterns of the existing culture. This meant a very hard, tough program of selling the new ideas within the organization as well as an extensive and personal effort to get the new messages and thinking to our potential customers.*

As the key processes were identified and their objectives determined, the company began to think about how information technology (its own and from other providers) could enable and support the processes. The facilitating director of processes and systems, Paul Chapman, decided that the firm needed a new approach to developing information systems around processes. His organization used the information engineering approach discussed earlier and worked with an external consultant to refine and confirm process identification. They uncovered 18 "macro" business processes (e.g., logistics) and 145 "micro" processes (e.g., fleet management).

The senior management team reconvened to prioritize the identified processes and decided that seven macro processes had particular importance: customer order life cycle, customer satisfaction, installed equipment management, integrated planning, logistics, financial management, and personnel man-

*David O'Brien, quoted in B. Denning and B. Taylor, "Rank Xerox U.K., Office Systems Strategy (C): Developing the Systems Strategy," (Henley on Thames, England. Henley–The Management College case study, September 1988). Other Rank Xerox U.K. information comes from personal interviews.

agement. It selected personnel management as the first process to be redesigned because this was viewed as relatively easy to attack and because personnel systems were crucial in tracking the development of new skills. The personnel system has now been successfully redesigned, using automated code generation capabilities, in substantially less time than if normal methods had been used.

RXUK's financial situation began to improve as it redesigned its business processes. The company emerged from a long period of stagnation into a period of 20 percent revenue growth. Jobs not directly involved with customer contact were reduced from 1,100 to 800. Order delivery time was, on average, reduced from thirty-three days to six days. Though many other market factors were changing during this time, O'Brien credits the process redesign for much of the improvement.

Other Xerox divisions heard of RXUK's success with process redesign and began efforts of their own. Xerox's U.S. product development and marketing divisions now have major cross-functional teams performing process redesign. Paul Chapman has been loaned to Xerox corporate headquarters, where he is heading a cross-functional team looking at corporate business processes. Commitment to IT-driven process redesign by Xerox senior corporate management is also growing.

management processes include improving analytic accuracy, enabling broader management participation across wider geographical boundaries generating feedback on actions taken (the managerial version of "informating" a process), and streamlining the time and resources a specific process consumes. Texas Instruments and Xerox's corporate headquarters provide excellent examples.

Texas Instruments has developed an expert system to facilitate the capital budgeting process. Managers in a fast-growing and capital-intensive TI division were concerned that the time and experience necessary to prepare capital budget request packages would become an obstacle to the division's growth. The packages were very complex and time consuming, and few employees had the requisite knowledge to complete them accurately. The expert system was developed by two industrial engineers with expertise in both the technology and the budget process.

TI's system has radically improved the capital budget request process. Requests prepared with the system require far less time than the manual approach and conform better to the company's guidelines. One experienced employee reported a reduction in package preparation time from nine hours to forty minutes; of the first fifty packages prepared with the system, only three did not conform to guidelines, compared to an average of ten using a manual approach.[30]

At Xerox Corporation headquarters, IT has been used to improve the review of division strategic plans. Prior to the development of the company's Executive Information System (EIS), the planning process was somewhat haphazard; each division prepared its planning documents in a different format and furnished different types of information to corporate headquarters. Plans often came in too late for the corporate management committee to review them before the quarterly or annual review meeting. The EIS was developed to include standard information formats and a user friendly graphical interface enabling fast comprehension. Divisional plans are now developed on the EIS and delivered instantaneously over Xerox's network to all corporate management committee members. These members can now read and discuss the plans beforehand and can move directly to decisions at the review meetings. The workstations are even used in the meetings themselves, allowing revisions to be made and agreed upon before adjournment. As one manager put it, ". . . [the system] lets us communicate at higher speed and in greater depth."[31]

Management Issues in IT-Enabled Redesign

Companies have found that once a process has been redesigned, several key issues remain. These include the management role in redesigned activity, implications for organization structure, new skill requirements, creating a function to perform IT-enabled BPR, the proper direction for the IT infrastruc-

ture, and the need for continuous process improvement. We discuss each below.

Management Roles

Perhaps the greatest difficulty in IT-driven redesign is getting and keeping management commitment. Because processes cut across various parts of the organization, a process redesign effort driven by a single business function or unit will probably encounter resistance from other parts of the organization. Both high-level and broad support for change are necessary.

To perform the five redesign steps described above, several companies created a cross-functional task force headed by a senior executive. These task forces included representatives from key staff and line groups likely to be affected by the changes, including IT and human resources. It was particularly important that the customer of the process be represented on the team, even when the customer was external. The team composition was ideal if some members had some record of process or operations innovation involving IT.

As the redesign teams selected processes and developed objectives, they needed to work closely with the managers and staff of the affected units. Managing process change is similar to managing other types of change, except that its cross-functional nature increases the number of stakeholders, thereby increasing the complexity of the effort.

It was also important to have strong, visible commitment from senior management. Employees throughout the organization needed to understand that redesign was critical, that differences of opinion would be resolved in favor of the customer of a process, and that IT would play an important role. In many cases, the CEO communicated any structural implications of the redesign effort.

An example of the importance of the CEO's role is found at GUS Home Shopping, the largest home shopping company in Europe. GUS undertook a $90 million project to redesign its logistical processes with IT. Redesign objectives involved both cost and time: to be able to sell a product within five minutes of its arrival on the loading dock, and to be able to deliver a product to the customer's door at an average cost of sixty cents. The company's managing director commented on his role in meeting these objectives:

> To change our business to the degree we have [done] demands integration. How involved should the managing director get in designing computer systems? My view is totally, because he's the one who can integrate across the entire organization.[32]

Process Redesign and Organizational Structure

A second key issue is the relationship between process orientation and organizational structure. Certainly someone must be in charge of implementing a process change, and of managing the redesigned process thereafter. But process responsibilities are likely to cut across existing organizational structures. How can process organization and traditional functional organization be reconciled?

One possible solution is to create a new organization structure along process lines, in effect abandoning altogether other structural dimensions, such as function, product, or geography. This approach presents risks, however; as business needs change, new processes will be created that cut across the previous process-based organization. This does not mean that a process-based structure cannot be useful, but only that it will have to be changed frequently.

While no firm we studied has converted wholly to a process-based structure, a few organizations have moved in this direction. For example, Apple Computer recently moved away from a functional structure to what executives describe as an IT-oriented, process-based, customer satisfaction-driven structure called "New Enterprise." The company relishes its lack of formal hierarchy; Apple managers describe their roles as highly diffuse, and team and project based.

A more conservative approach would be to create a matrix of functional and process responsibilities. However, because of the cross-functional nature of most processes, the functional manager who should have responsibility for a given process is not always easy to identify. The company may also wish to avoid traditional functional thinking in assigning process responsibilities. For example, it may be wiser to give responsibility for redesigning supplies acquisition to a manager who uses those supplies (i.e., the customer of the process), rather than to the head of purchasing.

New Skill Requirements

For process management to succeed, managers must develop facilitation and influence skills. Traditional sources of authority may be of little use when process changes cut across organizational units. Managers will find themselves trying to change the behavior of employees who do not work for them. In these cases, they must learn to persuade rather than to instruct, to convince rather than to dictate. Of course, these recommendations are consistent with many other organizational maxims of the past several years; they just happen to be useful in process management as well.[33]

Several organizations that are moving toward IT-driven process management are conducting programs intended to develop facilitation skills. These programs encourage less reliance on hierarchy, more cross-functional communication and cooperation, and more decision making by middle- and lower-level managers. Such a program at American Airlines is being used to build an organizational infrastructure at the same time a new IT infrastructure is being built.

An Ongoing Organization

Organizations that redesign key processes must oversee continuing redesign and organizational "tuning," as well as ensure that information systems support process flows. In most companies, the appropriate analytical skills are most likely to be found in the IT function. However, these individuals will also require a high degree of interpersonal skills to be successful as the "new industrial engineers." The ideal group would represent multiple functional areas, for example, information systems, industrial engineering, quality, process control, finance, and human resources.

There are already some examples of such process change groups. Silicon Graphics has created a specific process consulting group for ongoing process management; it is headed by a director-level manager. At United Parcel Service, process redesign is traditionally concentrated in the industrial engineering function. The UPS group is incorporating IT skills in the IE function at a rapid rate, and creating task forces with IT and IE representation for process redesign projects. Federal Express has gone even further, renaming its IE organization the "Strategic Integrated Systems Group," placing it within the Information Systems function, and giving it responsibility for designing and implementing major IT-driven business changes

Process Redesign and the IT Organization

Just as information technology is a powerful forc in redesigning business processes, process thinkin has important implications for the IT organizatio and for the technology infrastructure it build: Though few IT groups have the power and influence to spearhead process redesign, they can play several important roles. First of all, the IT group may need to play a behind-the-scenes advocacy role, convincing senior management of the power offered by information technology and process redesign. Second, as demand builds for process redesign expertise, the IT group can begin to incorporate the IE-oriented skills of process measurement, analysis, and redesign, perhaps merging with the IE function if there is one. It can also develop an approach or methodology for IT-enabled redesign, perhaps using the five steps described above as a starting point.

What must the information systems function do technologically to prepare for process redesign? IT professionals must recognize that they will have to build most systems needed to support (or enable) processes, rather than buy them from software package vendors, because most application packages are designed with particular functions in mind. IT professionals will need to build robust technology platforms on which process-specific applications can be quickly constructed. This implies a standardized architecture with extensive communications capability between computing nodes, and the development of shared databases. However, like the organizational strategies for process management described above, these are appropriate technology strategies for most companies, whether or not they are redesigning processes with IT.

Continuous Process Improvement

The concept of process improvement, which developed in the quality movement, requires first that the existing process be stabilized. It then becomes predictable, and its capabilities become accessible to analysis and improvement.[34] Continuous process improvement occurs when the cycle of stabilizing, assessing, and improving a given process becomes institutionalized.

IT-enabled business process redesign must generally be dynamic. Those responsible for a process should constantly investigate whether new information technologies make it possible to carry out a process in new ways. IT is continuing to evolve, and forthcoming technologies will have a substantial impact on the processes of the next decade. The IT infrastructure must be robust enough to support the new applications appropriate to a particular process.

Summary

We believe that the industrial engineers of the future, regardless of their formal title or the organizational unit that employs them, will focus increasingly on IT-enabled redesign of business processes. We have only begun to explore the implications and implementation of this concept, and only a few companies have ventured into the area. Many companies that have used IT to redesign particular business processes have done so without any conscious approach or philosophy. In short, the actual experience base with IT-enabled process redesign is limited.

Yet managing by customer-driven processes that cross organizational boundaries is an intuitively appealing idea that has worked well in the companies that have experimented with it. And few would question that information technology is a powerful tool for reshaping business processes. The individuals and companies that can master redesigning processes around IT will be well equipped to succeed in the new decade—and the new century. ■

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Reengineering the Sales Function: Reengineering Internal Operations

Eric K. Clemons
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Many, if not most, consumer packaged goods companies have recognized the need to restructure the way they market, sell, and distribute their products in the 1990s. Several functional areas, in particular Marketing, Sales, Purchasing, Manufacturing, and Distribution, must all coordinate and work together if customer orders are to be taken and filled in a timely and cost effective manner, and if adequate customer service is to be achieved at acceptable cost. It is useful to note that the stereotypical descriptions of personnel from Marketing, Sales, and Manufacturing have historically had some justification. Marketing brand managers tend to have MBA degrees and are concerned with the long term growth of their brands, including use of focus groups to determine consumer interest, development of alternative packaging, management of promotional and advertising budgets, and the development of line extensions such as *Apple Newtons* and *Strawberry Newtons*, or *Double Stuff Chocolate Covered Mint Oreos*. Sales personnel historically have not always had undergraduate degrees; they are concerned with very short term sales, and with maintaining good long term inter-personall relationships with their key buyers. Manufacturing personnel often have engineering degrees, have been extremely analytical, and would like the simplest possible product mix, the most standardized packaging, and the longest and most certain scheduling period, to control manufacturing costs.

In many consumer packaged goods companies, a combination of bad information flows, bad organizational design, and bad incentive systems has resulted in poor performance. Sometimes this poor performance is readily apparent: orders go unfilled and customers are angry. In other organizations the resulting poor performance may manifest itself as costs far higher than necessary; this may remain undetected for some time, until more cost effective competitors are able to offer more attractive prices to customers, and as a result begin to capture market share.

At SNM[1] Pharmaceuticals information flows and the flows of physical products have become separate and at best weakly coupled. Information flows are summarized below:

<u>Marketing</u>:	Sets projected sales by category, product, and SKU (stock keeping unit, which represents a specific packaging format and size of a specific product)[2]. These projections are used to set preliminary manufacturing schedules and are an input in the setting of monthly and quarterly targets for sales personnel.
<u>Sales</u>:	Reports specific orders from individual customers back to manufacturing and marketing.
<u>Manufacturing</u>:	Sets daily production schedule, which is locked and cannot be changed after fewer than 30 days separate the current date and the schedule. The schedule is based on available inventory and on sales forecasts from marketing, and can be modified if extraordinary customer orders are observed before the 30-day lock-in period. The manufacturing schedule runs through an MRP systems (materials requirements planning) so that necessary raw materials will be available from up-stream suppliers.

Likewise, physical flows are summarized below:

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[1] SNM Pharmaceuticals and Plover Detergents are disguised but real companies, highly regarded in their industries. The companies are not caricatures, and the operations described here accurately reflect operations within each company before their reengineering efforts. Additionally, while the cases described here provide an interesting basis for the discussion of reengineering, they are not presented as examples of especially bad organizational design; similar structures were all too common at the time that these companies were studied.

[2] Detergent is a category. Surf is a product. The 48 oz. size of heavy duty liquid Surf is a stock keeping unit.

<u>Raw Materials</u>: Flow into manufacturing; 30 days is always more than sufficient for SNM to achieve restock from suppliers.

<u>Product</u>: Flows from manufacturing to inventory or directly to loading dock for shipment to customers; also flows from inventory to loading dock for shipment to customers.

At SNM, when insufficient stock was available for fulfilling all customer orders and it is necessary to allocate scarce inventory, orders are filled according to time priority. The orders that had been received first by sales personnel are filled first, regardless of when the sales representative had actually made the orders public and reported them into the organization, until available stocks are exhausted. Customers are informed as soon as the company determines that their orders cannot be filled; unfortunately, given the unpredictable flow of information between sales and manufacturing, these stock-outs may not be detected until a considerable time after the orders were placed with sales personnel.

Since the functional division of the company made it difficult for the chief operating officer to exercise any form of coordinated direct control over operations, incentives had been designed to try to achieve desired performance objectives. These incentives are summarized below:

<u>Manufacturing</u>: Manufacturing is rewarded based on the cost of goods sold. Thus, manufacturing is rewarded only for controlling the cost associated with items that are actually manufactured.

<u>Inventory</u>: Formally, Inventory Management is associated with the same technical operations group as manufacturing, and thus has cost-based incentives. Inventory Management is rewarded for keeping the lowest possible levels of working capital tied up in finished goods inventory. The simple metric used is to measure the total value of inventory on hand at the end of the fiscal year, 31 December, and to use this in the calculation of annual bonuses for the Inventory Management group.

Sales: Sales personnel are rewarded for beating their personal monthly and quarterly sales targets; all incentives are for individuals and not for Sales as a group. Sales personnel are not penalized for monthly or quarterly shortfalls, as long as they meet annual targets. These incentives are based on total dollar value of product orders, and are not broken down by SKU. Items that cannot be shipped because they are not available are still included in the value of the sales personnel's orders.

Marketing: Marketing personnel are rewarded for growth in their brands' or categories' sales.

Customers: SNM has taken no explicit steps to manage the incentives or influence the behavior of customers (retailers). Customers receive only limited advantages from placing their orders early if sales personnel do not report their orders in a timely fashion.

Useful facts are summarized below:

- Given the nature of SNM's product markets, the greatest single determinant of year-to-year differences in SNM's product sales is the winter quarter's sales. SNM's winter sales is greatly influenced by the strength or virulence of the current year's flu strain. Epidemiologists have not been very accurate in their predictions; remember the swine-flu epidemic that never materialized

- There is great concentration among SNM's buyers. A few key accounts such as Wal-Mart, Kmart, Rite Aid, Thrift Drug, and Krogers, contribute the vast majority of SNM's annual sales. In this case, 10% of accounts contribute 90% of sales.

- Customers know their intended orders well in advance. Before printing advertising circulars and free-standing newspaper inserts

(FSIs), retailers decide on their sales price, which is the greatest determinant of their order quantity. Retailers order their FSIs well in advance, and well outside SNM's 30-day lock-in period for manufacturing scheduling.

The following problems have been observed for several consecutive years:

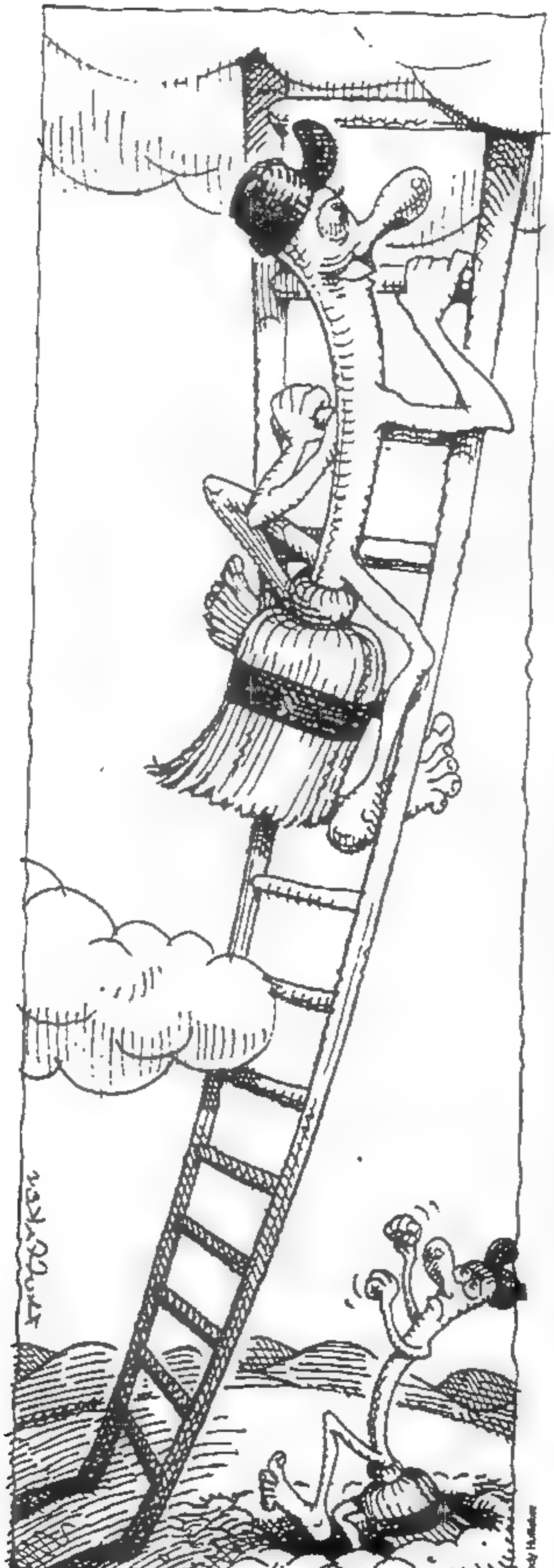
- Order fill rates in January, February, and March have been awful. These have been the months of highest consumer demand for SNM's products. Additionally, marketing has traditionally scheduled preemptive promotional campaigns in these months, so that retailers and consumers would stock up and thereby preclude competitors' products from making sales. However, fill rates have been so bad that these promotions have, in the words of an SNM vice president, become "annual major account alienation events".

- SKUs in sales personnel's orders frequently do not match SKUs available in inventory or scheduled to be manufactured in time for order shipment, exacerbating fill rate problems.

- There is insufficient lead time on many large orders; that is, they come in after the 30-day schedule lock-in, and there is insufficient inventory to allow the order to be filled. This occurs with surprising frequency towards the end of each month, and with even greater frequency near the end of each quarter.

SNM's preferred approach to improving organizational performance has been to encourage marketing to attempt to develop a better and more detailed model, which would predict sales for each product and for each SKU, on a weekly basis, so that manufacturing scheduling could be done more accurately. However, after two years, this effort was largely unsuccessful. A consultant to the Marketing department suggested that the modeling approach probably could not ever succeed, and suggested that incentives could be changed so that the sales team would report orders sooner. The SVP for Marketing became quite angry, and suggested that if Sales had been paying for the study this might be a valid approach, but as long as Marketing was paying for the work it

was Marketing that would receive any benefits from updating the incentive system at SNM.



Sell the mailroom

Peter F. Drucker

More and more people working in and for organizations are actually on the payroll of an independent outside contractor. Businesses, hospitals, schools, governments, labor unions—all kinds of organizations, large and small—are increasingly "unbundling" clerical, maintenance, and support work.

Of course, the trend is not altogether new. A great many American hospitals—and European and Japanese hospitals as well—now farm out maintenance and patient feeding; 40 years ago none did. "Temporary help" firms go back more than 30 years; but while in the beginning they handled file clerks and typists, they now provide computer programmers, accountants, engineers, nurses, and even plant managers. Cities farm out "waste management" (once known as street cleaning and garbage disposal); even prisons are being run by private contractors.

Farming out clerical work

This trend is accelerating sharply in all developed countries. In another 10 or 15 years it may well be the rule, especially in larger organizations, to farm out all activities that do not offer the people working in them opportunities for advancement into senior management. This may indeed be the only way to boost productivity in clerical, maintenance, and support work. And rising productivity in service jobs will become a central challenge in developed countries, where such work now employs as many people as manufacturing does.

Support work is rapidly becoming capital-intensive. In many manufacturing companies, the investment in information technology for each office employee now equals the investment in machinery for each production worker. Yet the productivity of clerical, maintenance, and support work is dismally low, and is improving only at a snail's pace, if at all. Unbundling will not by itself make this work more productive. But without it the task of increasing productivity is unlikely to be tackled seriously.

In-house service and support activities are de facto monopolies. They have little incentive to improve their productivity; there is, after all, no competition. In fact, there are considerable disincentives to overcome. In the typical organization, whether business or government, the standard and prestige of an activity is judged by its size and budget—particularly in the case of activities that do not make a direct and measurable contribution to the bottom line. Improving the productivity of such activities is hardly the way to advancement and success.

When in-house support staff are criticized for doing a poor job, their managers are likely to respond by hiring more people. An outside contractor, however, knows that he will be tossed out and replaced by a better-performing competitor unless he improves quality and cuts costs. The people running in-house support services are also unlikely to do the hard, innovative, and often costly work that is required to make service work productive.

Systematic innovation in service work is as desperately needed as it was in machinery in the 50 years between

Don't do it yourself

"Vertical integration is a failed strategy. In today's fast-changing environment you must seriously and quickly consider subcontracting every task in the enterprise. It is virtually impossible to overdo subcontracting."

Globalization and U.S. entrepreneurism have created firms of all sizes that are capable of doing most any task. Companies will increasingly resemble shopping malls. Successful bosses from Toledo to Taipei increasingly will be those who best manage relationships with the most effective subcontractors—for plant watering, transportation management, or research.

Smallish subcontractors frequently are the best at delivering a specialized service or product. Because they are small, they are fast (which always saves big dough) and not heaped with overhead.

Surprisingly, research is one of the most vital areas for pursuing subcontracting. Consider proud Digital Equipment's recent top-of-the-line workstation offering: The microprocessors are designed and produced by relatively small MIPS Computer of Sunnyvale, Calif. Then there's MCI: It makes nothing, but its R&D shop is tops at ferreting out and then integrating the most innovative research efforts of the most sophisticated subcontractors of any size, from anywhere. To be sure, you can lose control of subcontractors. Many do by following Americans' characteristic adversarial ways of dealing with outsiders. The new arrangement demands "insiderization," to quote a participant. Share virtually all information with subs. Invite them to strategic and social events. Train them in your habits. Understand their core values and insist that they buy into your core values, not just your legal staff's contract details.

Tom Peters

Frederick Winslow Taylor in the 1870s and Henry Ford in the 1920s. Each task, each job, has to be analyzed and then reconfigured. Practically every tool has to be redesigned.

When Ray Kroc, the founder of McDonald's, set out to make hamburger shops more productive he redesigned every implement, including spoons, napkin holders, and skillets. To improve productivity, hospital-maintenance companies have had to redesign brooms, dust pans, wastepaper baskets, and even sheets and blankets. In building Federal Express, Fred Smith studied every step in the collecting, transporting and delivering of packages, and of billing for the work. And then people have to be trained and trained and trained. This requires single-minded, almost obsessive dedication to one narrow objective—making hamburgers, making hospital beds, delivering packages—to the exclusion of everything else. But such single-minded dedication is far more characteristic of an independent, outside entrepreneur than of a department head within an organization who is expected to be a team player.

The most important reason for unbundling the organization, however, is one that economists and engineers are likely to dismiss as "intangible": The productivity of support work is not likely to go up until it is possible to be promoted into senior management for doing a good job at it. And that will happen only when support work is done by separate, free-standing enterprises. Until then, ambitious and able people will not go into support work; and if they find themselves in it, will soon get out.

It is hardly coincidental that the productivity decline in American factories set in as soon as finance and marketing were taking over from manufacturing in the early '60s as the main avenues of advancement into senior management. Nor is it coincidence that stockbrokers have been plagued by recurrent "back office" crises despite steadily increasing employment and increasing investment in clerical and support work. Until very recently even the head of the back office (though responsible for half the firm's expenses) was at best a "titular" partner. Promotions, bonuses, and the time available on the part of top management were reserved by and large for traders, analysts, and salespeople.

Those people are "we;" the back office is "they." And one explanation of why noninstructional costs in colleges and universities have risen since World War II—to the point where they now account for almost two-fifths of the total bill—is surely that the people who run the dorms or the business office don't have Ph.D.s and are therefore nonpersons in the value system of academia.

Forty years ago, service and support costs accounted for no more than 10% or 15% of total costs. So long as costs were so marginal, low productivity did not matter. Now that they are more likely to take 40 cents out of every dollar, they can no longer be brushed aside. But value systems are unlikely to change. The business of a college, after all, is not to feed kids; it is teaching and research.

However, if support work is done by an independent contractor it can offer opportunities, respect, and visibility. As employees of a college, managers of student dining will never be anything but subordinates. In an independent company they can become vice president in charge of feeding the students in a dozen schools, or even CEOs of their firms. If they have a problem there is a knowledgeable person in their own firm to get help from. If they discover how to do the job better or how to improve the equipment they are welcomed and listened to.

Pushing vacuum cleaners to the top

In one large hospital-maintenance company, some of the women who started 12 or 15 years ago pushing brooms are now division heads or vice presidents and own substantial blocks of company stock. As hospital employees, most would still be pushing brooms.

Of course, there is a price for unbundling. If large numbers of people cease to be employees of the organization for which they actually work, there are bound to be substantial social repercussions. And yet there is so far no other option in sight for giving us a chance to tackle what is fast becoming a central productivity problem of developed societies.

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General Dynamics and Computer Sciences Corporation: Outsourcing the IS Function (A+B, Abridged)

It was June 1991, just over a year since Computer Sciences Corporation (CSC) and General Dynamics had first come into contact at a conference on information systems outsourcing. Now, the two companies were attempting to negotiate what could be the largest information systems outsourcing deal in history, dwarfing the 1989 Kodak outsourcing mega-contract both in size and complexity.

In the proposed arrangement, General Dynamics would sell its information systems organization, the Data Systems Division (DSD), to Computer Sciences Corporation; in addition, the staff of DSD would be transferred to CSC to continue to operate the data center assets. CSC would then use this capacity to provide information services to General Dynamics, as well as other clients.

It was an excellent opportunity for General Dynamics to continue to get superior information services at even lower cost while monetizing fixed assets and providing more flexibility for the future. In addition, General Dynamics considered the arrangement to be a valuable career opportunity for the employees of the Data Systems Division to enter a growth business in information services by joining CSC. The deal provided a brilliant opportunity for CSC to significantly enter the commercial information systems outsourcing market and achieve its corporate goal of gaining more commercial clients.

Ace Hall, corporate vice president, information systems and administrative services, and Larry Feuerstein, vice president, planning and quality assurance, were the managers of the General Dynamics Data Systems Division who had been involved in developing the deal with Van Honeycutt, president of CSC's Industry Services Group. Over 15 long months, these executives and their staffs had worked together to develop a plan that could benefit both companies.

This case was written by Research Associate Katherine N. Seger under the supervision of Professor F. Warren McFarlan as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

Now, they were entering more serious negotiations, and they focused on defining a plan for outsourcing the Data Systems Division which could be presented at the next General Dynamics Board of Directors meeting.

General Dynamics Company Background

General Dynamics, headquartered in St. Louis, Missouri, was the second-largest defense conglomerate in America. It provided tactical military aircraft, submarines, missile and electronics systems, armored vehicles, and space launch vehicles to the U.S. government. Its high-tech weapons systems included the Trident submarine, the M-1 tank, the F-16 fighter plane, and the Tomahawk cruise missile. In addition, General Dynamics owned and operated several smaller commercial subsidiaries. In the years of Cold War defense buildup, General Dynamics enjoyed a thriving defense market and sales grew to an all-time high of $10.2 billion in 1990.

In 1991, General Dynamics was composed of seven aerospace and defense divisions (**Exhibit 1**). Its four core defense groups were Space Launch Systems, Missiles and Electronics, Military Aircraft, and Marine and Land Systems. In addition, the company had two non-defense operations--the Resources group, and Cessna Aircraft. Finally, General Dynamics defined its own information systems organization as a separate division--the Data Systems Division.

- The Space Systems Division designed, manufactured, and supported space launch vehicles that carried defense and communications satellites into orbit around the earth.

- The Missiles and Electronics Group was mainly composed of two separate businesses. The Missile Systems business designed and manufactured air defense products such as the Tomahawk cruise missile, the Advanced Cruise Missile, the Sparrow, the Stinger, and the Phalanx gun system. The Electronics business produced avionics test equipment and provided information systems for the U.S. Air Force and radio systems for the Army. In addition, it designed and manufactured digital imagery and signal processing equipment for intelligence information gathering.

- The Military Aircraft Group designed and manufactured tactical aircraft. Its strongest product was the F-16 fighter, which served as the backbone of America's tactical aircraft fleet and was sold to other nations around the globe. In addition, the division had an equal share with Lockheed and Boeing in the design of the F-22 fighter, the next generation of tactical aircraft.

- The Marine and Land Systems Group was composed of two businesses. The Electric Boat Division was the nation's leading designer and builder of nuclear submarines. In 1991, the U.S. Navy awarded Electric Boat the contract to build SSN22, the second ship in the *Seawolf* class. The Land Systems Division designed and built land defense systems such as M1A1 Abrams main battle tank.

- The Resources Group was composed of three commercial operations. The Material Service Corporation produced aggregates, ready-mix concrete, and concrete pipe. Marblehead Lime produced lime for use in the steel industry and building materials. Freeman United Coal was a coal mining operation.

• Cessna Aircraft was a subsidiary that designed and manufactured small private business jets.

• The Data Systems Division (DSD) supported the company's corporate information systems and provided information services to all of General Dynamics's aerospace and defense divisions. (See below for more detail on DSD.)

The Board of Directors of General Dynamics totaled 16 members, comprising seven General Dynamics insiders, and nine outsiders. The chairman and chief executive officer of the company was William A. Anders, who had joined General Dynamics in 1990 as vice chairman and then became chairman in January of 1991. Prior to joining GD, Anders had been an astronaut on the Apollo 8 mission around the moon, the executive secretary of the National Aeronautics and Space Council, chairman of the Nuclear Regulatory Commission, ambassador to Norway, and an executive at two large industrial manufacturing companies.

The fall of the Berlin Wall in 1989 marked the beginning of the end of the Cold War. In 1991, communism collapsed in the Soviet Union; by 1992, the Soviet Union had crumbled into a federation of independent states. With the end of the Cold War, a growing federal deficit, and a troubled domestic economy, the United States government began to reduce procurement spending on military power from a high of $96.8 billion in fiscal 1985 to $54.4 billion in fiscal 1993,[1] causing the market for defense products and weapons to shrink dramatically. (See **Exhibit 2** for 100-year history of defense spending.)

This reduction in the defense market led to extreme overcapacity among suppliers and financial troubles for companies throughout the defense industry. In 1990, General Dynamics posted a loss from continuing operations of $674 million. (See **Exhibit 3** for financial summaries.) There seemed to be two major strategies for surviving this sharp decline in the defense market: (1) diversify capacity into commercial markets, or (2) downsize to a level that could be supported by a smaller defense market.

1991 GD Corporate Strategy

In 1991, Anders's top priorities for General Dynamics were to increase shareholder value and build financial strength and flexibility for the uncertain future. In this year's annual report, Anders wrote,

> Studies by outside consultants and by us clearly show that diversification by defense companies into commercial enterprises historically has had unacceptably high failure rates . . . . We believe that the process of widespread conversion of defense resources to commercial use at General Dynamics, while an alluring concept, is generally not practical. Instead, we are sticking to what we know best, and are therefore focusing more sharply on our core defense competencies.

This policy was part of Anders's philosophy of defense industry rationalization which he had refined during his first year as General Dynamics's CEO. Anders believed that defense companies could survive the changing marketplace only if the industry sufficiently downsized to meet the reduced demand. Overcapacity must be shed (not merely diversified) and the industry must consolidate so that individual companies could obtain a "critical mass" of the market in order to maintain profitability.

[1] Eric J. Savitz, "Hold the Taps for Defense Stocks," *Barron's*, Vol. 72, August 3, 1992.

In his 1991 letter to shareholders, Anders outlined three criteria for maintaining the strength of General Dynamics' individual businesses. For a business to remain viable, it must be within GD's core defense competency, it must be #1 or #2 in its field, and it must have a "critical mass" to ensure efficiency, economies of scale, and financial strength given the future business volumes available.[2] For businesses that did not fit these criteria, Anders's policy was "Buy, Sell, or Merge." In addition, Anders launched an aggressive campaign to increase General Dynamics's shareholder value. He instituted an executive compensation plan with heavy rewards for increased stock prices, and he sought out opportunities to monetize assets and generate more cash.

Larry Feuerstein commented on the power of Anders's corporate strategy within General Dynamics:

> Anders was *really* pushing his strategy out to all the executives and managers in the company. This was THE business strategy of General Dynamics, and it was reinforced daily for every employee Anders ever came in contact with. This was his singular focus.

It was with this corporate strategy in place that Larry Feuerstein and Ace Hall of GD's Data Systems Division began to look at outsourcing as a possible option for the future of the company's IS organization. As Feuerstein noted,

> General Dynamics is in the defense business, and data processing, admittedly, is not one of our core businesses. This is a great example of MIS really getting in line with corporate strategy. You read a lot about this, but rarely find such crisp examples of it really happening.

IT at General Dynamics: The Data Systems Division

Information technology was critically important to the operations of General Dynamics. Larry Feuerstein described computer technology as "the lifeblood" of GD's product units. Sophisticated computer systems were used in the operating units for product engineering, simulation, and manufacturing. Many of GD's products (such as "smart" cruise missiles) also had microcomputers installed directly within them. These proprietary embedded systems offered strategic advantage for GD's product lines. In addition, large computer systems were used to manage the company's business data in areas such as accounting, payroll, and inventory management. Information technology supported all aspects of General Dynamics operations; the quality and reliability of these information systems were crucial to the success of the company.

Prior to 1972, the information systems capabilities of General Dynamics were widely dispersed in the various business units of the company. In 1972, a study by Arthur Andersen recommended the consolidation of these facilities into regional centers to achieve more efficient and effective use of these resources. By 1976 this consolidation was complete, and the resulting organization--Data Systems Services--comprised three regional centers in San Diego, California; Fort Worth, Texas; and Norwich, Connecticut. At this time, the organization had 1,488 employees and was operated solely as a cost center. (See **Exhibit** 4 for DSD growth history.)

Larry Feuerstein joined the Data Systems Services management staff in 1976 at the Norwich center as it was being formed. Feuerstein recalls his experience at this time of

[2]From GD 1991 Annual Report.

organizational change as being excellent preparation for his role in the CSC outsourcing decision and implementation: "There was major turmoil. I saw the pain of changing relationships, fundamental restructuring, and consolidation. It was an important experience which I've drawn on throughout this CSC deal."

In 1981, the Data Systems Services organization was elevated to the status of an operating business unit and its name was changed to Data Systems Division (DSD). The charter for the DSD stated:

> *The Data Systems Division provides corporatewide guidance for, direction to, and management of the company's information resources and the information services required by the company's business units.*

The DSD Management Vision stated:

> *Working together as part of the General Dynamics Team, our people are recognized leaders in providing high-quality, cost-effective, information solutions to make our Company's processes and products the best in the world, improve competitiveness, and enhance shareholder value.*

The Data Systems Division had two main areas of responsibility: (1) the companywide direction of information resource strategies, policies, procedures, and standards; and (2) the provision of a full range of information services to General Dynamics operating units, including computer systems development, data processing for business systems, computer-aided design and manufacturing systems (CAD/CAM), engineering systems, and development of software that is embedded and delivered in General Dynamics products.[3]

The Data Systems Division facilities were located in the 3 large regional centers and 28 smaller service sites around the country. Hardware included 13 IBM mainframes, 3 Amdahl mainframes, a Univac mainframe, 2 Cyber scientific mainframes, a Cray scientific supercomputer, and 440 minicomputers. In addition, 3,700 engineering workstations and over 15,000 desktop micro-computers were scattered throughout the company's divisions. DSD operated three interconnected network layers--wide area, campus area, and work group. Capabilities included CAD/CAM, manufacturing, business applications, logistics, systems integration, electronic data interchange (EDI), distributed processing, and training. Total processing capacity for DSD was more than 1,000 MIPS (millions of instructions per second). The write-off lifetime for these fixed assets was a five-year accelerated depreciation for computer equipment and a five-year linear depreciation for software. In 1991, the DSD assets (including real estate, equipment, computer hardware, and licensed software) had a net book value of $140 million.

The Data Systems Division was staffed by highly skilled professional computer technicians and programmers. Their educations and careers were in information systems, and their salaries and benefits were competitive with IS professionals in other companies and industries. The majority of the DSD staff was located at the three regional centers or satellite service centers, with only a few (2 to 50) information systems people at each of GD's product division sites. These people served primarily as liaisons to the DSD service providers in the regional centers. When Ace Hall came in from General Dynamics's Corporate Planning Department to become general manager of the division in 1984, DSD had grown to 3,730 employees. In 1989, DSD reached its peak of 4,835 employees. By 1991, the staff had been

[3]From GD company records.

reduced to 3,400.[4] The DSD staff had been downsized in response to the shrinking defense market, mainly through attrition, reduced recruitment and hiring, and the elimination of selected positions. According to Larry Feuerstein, "We saw the market conditions, and we knew we were going to have to cut costs. We tried to manage downsizing in an orderly way, to avoid having to reduce the head count abruptly."

Each of the three regional data centers (West, Central, and East) served mainly the operating units in its region, giving each its own unique "clientele." A sophisticated charge-back billing system enabled the DSD to operate as a self-liquidating cost center. (See **Exhibit 5** for DSD cost flow chart.) Larry Feuerstein commented on the meticulous accounting of costs in DSD's billing system:

> DSD was a cost center operation for General Dynamics, but it was organized and managed like an independent business. We knew where to charge every cost we incurred. Most "garden variety" in-house IS departments are not organized like this. They have all kinds of costs commingled and buried in the "overhead" category.

DSD identified four main categories of costs within its structure--Professional Services, Computer Utility, Dedicated Resources, and Overhead Costs:

Professional Services included human services such as systems development, programming, consulting, and CAD/CAM.

Computer Utility was data processing on shared mainframe systems. These two categories were "rated"--GD divisions were charged at a given rate per unit of work for the amount of these resources consumed.

The rates[5] in these categories were determined by dividing the total cost to DSD in each category by the total units used in each. (The units used to define Professional Services rates were work-hours; the units used to define Computer Utility were volume units of processing resources.) The rate was then charged to each division for the particular amount of each cost category it consumed. These rates were reviewed monthly and adjusted at least quarterly by data center finance managers. Throughout the year, the divisions were charged at these *estimated provisional rates*. At the end of each year, the *actual rate* was calculated, and the divisions were charged or credited accordingly. According to Feuerstein, "The job of a good financial manager is to make sure the estimated rates are as close to the actual rate as possible. The division managers (our "clients") want the adjustment at the end of the year to be small--and they want it to be a credit, not a charge. Generally, our financial managers were good at their estimate adjustments."

Dedicated Resources included dedicated, division-unique (not shared) computer equipment and resources. These costs were "non-rated;" each business unit was charged directly at DSD cost incurred for these specific devices.

Finally, DSD *Overhead Costs* were fully allocated to the divisions as a percentage of total direct costs in each cost category. DSD divided its total overhead costs by the total of their direct service costs to get the overhead percentage. All of DSD's overhead was then applied at

[4] Of this number, approximately 800 individuals were assigned specifically to the development and installation of technology directly embedded in GD's products.

[5] Within the Computer Utility cost category, DSD identified eight different rates for resources such as disk usage, tape drive usage, and processor usage. In the Professional Services category, however, DSD identified only one rate per hour of professional time without differentiating the skill level or specific task of the professional.

this percentage to the other cost categories and included in the determination of rates charged to the divisions. In the non-rated category, overhead was applied as a percentage of the division's non-rated costs.

Describing the charge-out structure of DSD, Feuerstein commented on the success and importance of this complex system:

> This was a system that was well understood and accepted by the product division managers. They were used to it, they were generally comfortable with it, and it was predictable. In addition, the government accepted it. The Defense Contract Audit Agency looks over these charges with a fine-toothed comb, and they were comfortable with the existing structure.

DSD's total billable costs in 1991 were $375 million. Projected costs for 1992 were $370 million.[6] The breakdown of these 1992 costs by category (including overhead, which was projected to be 18% of direct costs) was as follows:

• Professional Services ("rated") systems development, CAD/CAM, consulting	$80 million
• Computer Utility / Processing Services ("rated") mainframe resources, tapes, disks	$82 million
• Dedicated Resources ("non-rated") dedicated division-unique resources and equipment	$208 million
TOTAL COST to GD	$370 million

General Dynamics Data Systems Division was widely considered to be a highly successful operation. For example, in 1989 and 1990, *Computerworld Premier 100* rated DSD number one in the aerospace industry based on its "clearly stated IS management vision, strong commitment to IS quality, strong user role in defining applications, and advanced factory-automation applications."[7] In spite of its outstanding service, however, DSD suffered, along with the rest of General Dynamics, from the sharp decline in the defense market. The reductions in the DSD head count and billings reflected this downturn in the industry.

With the new realities of the shrinking defense market, Hall began in 1990 to evaluate the future viability of the Data Systems Division. To address this issue, GD brought in a major general management consulting firm to do a strategic assessment of General Dynamics's information systems organizational structure.

Prior to the inception of this study, Ace Hall had sent Bob DeLargy, DSD vice president of finance, and Ken Wang, DSD director of systems integration, to a March 1990 conference on information systems outsourcing, which was emerging as an important trend in the information services field. Since the landmark 1989 Kodak outsourcing arrangement in which Kodak outsourced a large part of its business systems to three vendors, outsourcing had gained much attention and recognition as an important alternative solution for managing information services in the competitive economy of the 1990s. As more and more companies struggled to downsize and focus on their core businesses, outsourcing offered them a way to

[6] These DSD cost figures did not include the 800 programmers located in GD product divisions who developed product-embedded software. These software engineers were considered product division overhead.

[7] Mitch Betts, *Computerworld Premier 100*, October 8, 1990.

meet their information services needs without having to own and operate an information services business. Outsourcing was seen as an opportunity for companies to transform fixed overhead into variable costs, and free themselves from capital expenditures on information systems in an environment of rapidly changing technology. Companies found that they could receive better services at a lower cost while freeing up precious financial resources by outsourcing their IS needs to information systems experts. At the outsourcing conference, DeLargy and Wang heard a presentation by a corporate senior vice president of Computer Sciences Corporation who introduced CSC's outsourcing framework.

CSC Company Background

Computer Sciences Corporation, headquartered in El Segundo, California, was a leader in the information technology systems and services industry, with clients in both the federal and private sectors. The company described its business as follows:

> Computer Sciences Corporation (CSC) solves client problems in information systems technology. Its broad-based services range from management consulting in the strategic use of information and information technology to the development and operation of complete information systems. A leader in software development and systems integration, CSC designs, integrates, installs, and operates computer-based systems and communications systems. It also provides multidisciplinary engineering support to high-technology operations and specialized proprietary services to various markets. The company manufactures no equipment.[8]

In 1991, CSC had over 23,000 employees and was composed of four major business groups: the Systems Group, the Industry Services Group, the Consulting Group, and CSC Europe.

The Systems Group was CSC's largest operating entity and major technological resource. It provided software, systems development, and systems operations primarily to the US government. This federal client base consisted of hundreds of contracts with a wide range of the government's administrative, scientific, and military agencies, including NASA, the EPA, the National Weather Service, the Postal Service, the Air Force, the Navy, and the Army. The Systems Group had extensive experience specifically in the development of software for aerospace and defense systems, satellite communications, intelligence, logistics, and related high-technology fields. In 1990, the Systems Group's federal contracts accounted for 66% of CSC's total revenue. CSC was known as the premier contractor of information systems services to the U.S. government. With the Systems Group as its largest unit, the company had developed much of its expertise on large-scale government systems.

CSC's commercial customers were served primarily by its Industry Services Group and its Consulting Group. The Industry Services Group handled information services, including facilities management and systems operations, for health care, insurance, and financial-services customers. The Consulting Group (comprising subsidiaries such as CSC Index and CSC Partners) worked with businesses to develop strategic plans for information technology and to design and implement integrated computer and communications systems that would fully support the customer's management objectives. (See **Exhibit 6** for CSC organization chart.)

CSC was a successful and strong company. In 1991, the company set records in revenue and earnings from operations. Worldwide commercial revenue increased 32% from

[8] From CSC Annual Report, 1990.

$508 million to $668 million, and federal revenues increased 8% from $993 million to $1.07 billion, resulting in a total revenue of $1.74 billion in 1991, up 16% from the previous year's $1.5 billion. (See **Exhibit 7** for financial summaries.) CSC also had an excellent record of capturing new business opportunities. Over the period 1985-1990, the company won 54% of new federal contracts it bid on.

CSC's success was due to three decades of experience in software development and information systems management, combined with comprehensive knowledge of the information and application requirements of various industries and highly specialized government activities. The company had a deep and rich base of knowledge to bring to bear on information problems in both the public and private sectors. In addition, CSC differentiated itself in the information services market by its strong focus on quality and client satisfaction. According to William Hoover, chairman, president, and CEO,

> Performance management and client satisfaction are the dominant factors that have differentiated CSC in the industry. We have a high reputation for quality performance and delivering the systems that our clients ask us to build.[9]

In 1991, Computer Sciences Corporation was governed by an eight-person Board of Directors, comprising three CSC insiders (President William Hoover, the chief financial officer, and the president of the Systems Group) and five members from other organizations.

CSC Corporate Strategy

1991 marked the end of a five-year period in which CSC's main goals had been to improve its financial strength and increase its presence in the commercial information services market.[10] Over the period, the company had succeeded in steadily increasing its revenue every year by an average of 15%-16%. The company had also made significant progress in increasing its commercial business. In 1989, U.S. commercial revenue accounted for 19% of CSC's total revenue; in 1990, U.S. commercial revenue rose to 21%; and in 1991, it was at 24% of the company's total revenue. (See **Exhibit 8** on revenue distribution by markets.) As William Hoover predicted in 1989,

> We're going to see a shift in our customer mix from the federal sector to the non-federal sector. We have a strong emphasis right now in taking our technology base and our project management base that we developed in the federal sector in communications/computer systems integration and applying that to the emerging needs of commercial organizations in the United States and Europe--the Fortune 500 and large corporations that have broad, diversified information systems requirements.[11]

While the company's revenue distribution in commercial markets was growing, CSC still was not considered a dominant leader in commercial information services in 1991. As Van Honeycutt described it, "Whenever anyone listed the top providers of information services to commercial industry, CSC seldom made the elite list." One reason for CSC's slowness in entering this market, according to Honeycutt, was actually a positive--its long history and reputation as the premier provider of information services to the U.S. government. According

[9]From an interview with William Hoover in *CEO Interviews*, May 1, 1989.
[10]Cowan and Company, *Perspectives*, August 1989, p. 2.
[11]From an interview with William Hoover in *CEO Interviews*, May 1, 1989.

to its 1991 annual report, the company's goal in the commercial sector was to be one of the industry's top three professional services firms.

The General Dynamics deal was a brilliant opportunity for CSC because it would allow the company to achieve this goal. A contract of that size would immediately place CSC among the top four providers of information services to commercial industry. In addition, company officials believed that the new assets acquired from GD would enable CSC to attract other new commercial customers.[12]

History of Outsourcing Business at CSC

In the late 1980s, at the same time CSC was trying to grow its presence in commercial markets, information systems outsourcing was beginning to emerge as an important business trend. The landmark 1989 Kodak outsourcing arrangement in which Kodak outsourced a large part of its business systems to three vendors was, according to Honeycutt, the "big bang; the point from which outsourcing really took off." As outsourcing began to emerge in the information services industry, CSC had to decide how to address this new trend. It was definitely a business that the company wanted to be in, for it offered an excellent opportunity to serve commercial clients. But how to enter this new market?

In 1990, CSC decided to develop its outsourcing business in the part of the company which provided information services to commercial clients--the Industry Services Group. The Industry Services Group had a staff of approximately 3,500 professional information systems technicians and programmers operating in 5 data centers across the country. Their skills in data center management closely matched the skills needed to succeed in the outsourcing business. While CSC's Consulting Group had more commercial contacts, their skills were in strategic planning and development of information systems, not in the actual operation of those systems. It was the Industry Services Group that provided extensive, on-going information processing services to commercial clients in such areas as insurance, financial services, and health care.

The two commercial groups in CSC, for example, worked with Bay State Health Care, the fastest-growing HMO in Massachusetts, to build an open systems architecture that would allow better customer service, faster communications, streamlined paperwork, and lower operating costs by mixing a wide range of technologies. They also enabled a leading Midwest lending firm to revamp its mainframe-driven, centralized system to create a decentralized, distributed system that put more computing power in the hands of users. A major West Coast insurance company drew on the Industry Services Group's systems and software expertise to speed the handling of claims for more than 250,000 members who submit an average of 100,000 claims per month. Hewlett-Packard turned to CSC to develop a logistics system to improve the efficiency of its repair parts operation. The system improved the availability of parts by streamlining the ordering and delivery process and improved methods of tracking inventory.

Van Honeycutt, president of the Industry Services Group, began by putting together a special marketing team to call on CSC Partners and Index customers. He recalled:

> We had several false starts, and no takers. There was a container company, for example, who decided to outsource their IS needs, but they ended up going to IBM because they were concerned about our government background. We stirred up a lot of dust, but no contracts.

[12]Pauline Yoshihashi, "Computer Sciences Signs Pact to Provide Technical Services to General Dynamics," *Wall Street Journal*, Sept. 24, 1991, A 9:1.

Eventually CSC had the opportunity to buy a small IS outsourcing company in North Carolina called CompuSource, which served commercial clients. According to Honeycutt, "We bought it and added it to the Industry Services Group. This gave us some additional credibility in the commercial outsourcing market."

Honeycutt also worked with his marketing team to develop an outsourcing framework that would appeal to Fortune 500 companies. "We pretended we were a Fortune 500 company in trouble or looking to improve information systems effectiveness. What would we want to hear? What are our critical needs?" Out of this thinking, Honeycutt and his marketing team developed a framework for CSC's outsourcing service. They recognized that there were many vendors in the market who provided "outsourcing" with different definitions of the word. Most information services providers were "functional outsourcers" or "partial outsourcers;" they took on only one system or one portion of a company's overall information technology needs. Honeycutt decided to distinguish CSC in the market as the "total outsourcer." In an outsourcing agreement, CSC would provide total information services to its clients by becoming a company's "information services partner." As Honeycutt explained,

> Outsourcing with CSC would be a transaction not at the functional level, but at the CEO and boardroom level. We become an integral partner of the company's senior management as we take over all responsibility for the company's information services needs. We *become* their IT resource.

After developing this marketing framework, Honeycutt worked to increase CSC's visibility in the outsourcing arena. CSC representatives gave speeches, participated in panels, and attended conferences to try to sell their outsourcing framework to the commercial market.

General Dynamics's Bob DeLargy, DSD vice president of finance, and Ken Wang, DSD director of systems integration, attended one such conference in March of 1990 where they heard one of Honeycutt's colleagues present CSC's outsourcing framework. This presentation was so compelling that DeLargy and Wang invited CSC to address the next DSD strategic planning meeting later that month to present their outsourcing framework as another potential option for the future of DSD.

The Outsourcing Decision

General Dynamics's interaction with CSC officially began when CSC was invited to present its "total outsourcing" framework to DSD management at its strategic planning session in March 1990. After this meeting, DSD management was impressed with CSC and agreed that outsourcing as a possible solution for General Dynamics's information services needs warranted further study.

1990

Over the next several months, several key managers from CSC and DSD continued a dialogue on the subject of outsourcing, and eventually, the idea evolved into a proposed joint venture project between CSC and General Dynamics. In August of 1990, Van Honeycutt formally presented the joint venture concept to Ace Hall. He proposed a shared-equity business venture of which CSC would have the majority interest; the new business would provide information services to General Dynamics and other clients. Through the end of 1990, Hall, Feuerstein, and other DSD managers remained interested in the CSC proposal and arranged several meetings with Honeycutt and other CSC managers to refine the details of the concept.

January 1991

In January of 1991, William A. Anders became General Dynamics's new CEO after having spent a year as vice chairman. His top priorities as CEO were to increase shareholder value and build financial strength and flexibility to ensure the survival of General Dynamics in the shrinking defense market. To drive his corporate strategy, Anders brought in Harvey Kapnick as GD vice chairman. In addition, Anders formed a Corporate Executive Council of GD's top executives and division heads for the purpose of instilling his strategy throughout the company. For the Council's first meeting, in March of 1991, Anders assigned "homework" for each member--he asked them to bring to the meeting innovative ideas for implementing his corporate strategies and managing GD in the shrinking defense market of the future. .

March 1991

At this council meeting, Ace Hall presented the idea of a joint venture with CSC to provide information services to GD and other clients. Anders and the Executive Council were interested in the proposal, and Jim Mellor, GD president and chief operating officer, asked Hall to present the CSC option at an upcoming meeting in May, at which the consulting firm was scheduled to present their findings and recommendations for GD's future information services structure.

May 1991

In what Larry Feuerstein described as "an *intense* six-hour session," Jim Mellor and other GD corporate managers heard first from the consulting firm. The consultants recommended maintaining the information systems facilities within General Dynamics, but eliminating the centralized Data Systems Division and returning the IS capabilities to the individual business groups. This plan was estimated to result in a cumulative savings of $243 million over a four-year period. Feuerstein noted, however, that he was skeptical of their numbers and wary of their plan:

> I thought their numbers were probably overstated, and their implementation plan made me nervous. They wanted us to go back to the the IS structure we had in 1973, before we consolidated into a centralized data systems organization. But that kind of a structure wouldn't work for us today. Our IT capabilities had become so specialized that I doubted the operating units had enough expertise to manage them well. In addition, by being centralized, we had achieved economies of scale that would be lost if DSD was broken up and parceled out to the other divisions. Finally, it would not have been good for our people. Frankly, IS professionals are seen as "second-class citizens" by the product engineers in the operating units. Spread out across these units, they would lose the professional community and career development opportunities that DSD was able to offer. We would end up losing our best people to other companies that could offer them a better career path.

With the consulting team still at the conference table, Feuerstein then presented the CSC idea, which he called "Another Potential Option for Information Systems Structural Change." He explained the history of the joint venture proposal and gave background on CSC, highlighting its strong financial position and extensive experience in government information systems. He identified the benefits for GD as cost reductions for information services, a large cash infusion (since CSC would purchase GD's IS facilities for the new business), and the opportunity to participate in the growth market of commercial outsourcing. The risks, however, were the loss of GD's full control over its IS resources, the potential failure of the new business, and the uncertain growth of the commercial outsourcing market. Feuerstein's

main goal in this meeting was to learn whether or not there was enough interest on the part of corporate headquarters to explore this option further.

At the end of the meeting, and much to the surprise of the consultants, Mellor was very enthusiastic about the CSC option. As Feuerstein later noted, "It was critical that Mellor was positive. We would never have done this deal without operating management's buy-in." Mellor suggested that Hall and Feuerstein present the plan to Harvey Kapnick, GD vice chairman, whom Anders had brought in to drive his corporate restructuring strategy. As Feuerstein explained,

> Kapnick was Anders's shareholder-value-enhancement and divestiture guy. It was an incredible bit of fate, too, because Kapnick had been a top executive of another computer services firm, and so he understood the intricacies of MIS and was immediately drawn to this plan. This was an important subtle nuance in this whole process.

Kapnick was interested in the concept and agreed to meet with top CSC people to discuss the proposed business venture. On May 22, Ace Hall, Larry Feuerstein, and Harvey Kapnick met for dinner at the St. Louis Club with Van Honeycutt, CSC CEO William Hoover, and a CSC corporate senior vice president. As Honeycutt described it,

> This was Harvey Kapnick's "get-to-know-you meeting." The first thing Kapnick wanted to know was whether we had the kind of money for a deal like this. He really wanted the cash. Next, he wanted to know who from CSC would be in charge. Again, he was testing our level of commitment to this deal. It was critical that we had Hoover there; we were pitching the whole company, and his presence gave us credibility. After that, things settled down and went very smoothly. There seemed to be a good personality fit around the table. Kapnick and one of our guys had a mutual past experience before coming to GD, so they shared an immediate connection. At the end of the evening, Kapnick said that he would work with us, provided we get Jim Mellor [GD's president and chief operating officer] on board.
>
> It was critical that Jim Mellor and his operations managers be behind this deal because IS runs throughout all of GD's business divisions. They were the DSD customers, and they would become CSC customers if this plan went through. They had to be convinced that we could do the job for them.

As Feuerstein described it,

> It was a very positive meeting. Harvey [Kapnick] and Bill [Hoover] hit it off very well. And since Kapnick and a member of the CSC team had some mutual experience, there was instant common ground. They traded names and stories for a long time, helping to set a positive tone. The group was congenial; there was an immediate "fit." This was a critical "chemistry test." Had that meeting not gone so well, the whole idea might well have gone straight to the filing cabinet. After dinner, Harvey said to Ace and me, "These are good guys; I could work with them." And that was our go-ahead.

June 1991

Throughout early June, various teams of GD and CSC people traded visits to one another's facilities. Feuerstein noted that:

> CSC has an extremely good ability to muster a companywide team of great, intelligent, experienced people. The right individuals were there within 48 hours. They really know how to respond to a deal and pull it off.

Feuerstein invited a CSC review team to "come out and kick the tires" at DSD's regional data centers. According to Feuerstein, they were impressed with the IS facilities and personnel. Jim Mellor and several GD senior operations managers visited CSC offices and facilities to assess CSC operational capabilities. According to Honeycutt,

> We had to convince General Dynamics not only that we had the technical capability to handle their needs, but also that we had the right industry experience to be a good fit with their business. It's ironic that our extensive government and defense experience--which had previously been our obstacle to gaining commercial outsourcing clients--was now our selling point to GD. It was exactly what they were looking for. We spoke their language.

According to Feuerstein,

> The GD operations guys came away satisfied that CSC had the capability to serve their information needs. They saw that CSC had not only the technological capability, but also the "product fit" because of their extensive experience with government clients and weapons systems. CSC grew up in the same defense business as we did. They know the regulations and the critical success factors. We would have had to teach other vendors the rules of the defense environment before they could do the work.
>
> With their knowledge of the defense and high-tech industries, CSC was able to speak our language. This was another critical litmus test. Because IS runs throughout all of GD's operating units, we *had* to get the business units' buy-in. Mellor liked what he saw in the CSC facilities, and the operations managers were confident too. So he gave Kapnick the thumbs-up.

Later that month, Hall, Feuerstein, Kapnick, and GD's chief financial officer met with Honeycutt and Hoover to discuss terms for the proposed business venture. The main concern at this meeting was how to value the sale of GD's IS business. Honeycutt recalled this meeting:

> We did extremely good due diligence on this deal. We had some appraisals done of GD's technical assets, facilities, equipment, and real estate, and we knew this hard investment to be carried at some $140 million. We offered about $100 million for the division, and we proposed a 10-year contract with an annual charge for IS services that offered a slight savings over DSD's current charges. Kapnick told us in no uncertain terms, however, that our figure was totally unacceptable. He told us to get back to him when we could "clean up our numbers."

According to Feuerstein,

> This was the point where the deal began to crash and burn. The problem is that there is no precedent for valuation of this kind. There is no "used-car blue book" to understand how to value these assets. The net book value for the assets was $140 million; but because of the award-winning service DSD maintained, we also expected some premium above book value. Harvey Kapnick had worked in information services before, so he was very familiar with computer systems and facilities. He looked at the data we had and estimated the value of our business at

> perhaps $200 million. We went in to the meeting with CSC hoping to get near this amount. They offered us a 10 year contract with an annual charge for IS services that offered a slight savings over DSD's current charges. But the purchase price of $100 million they offered us for the business was not acceptable.

Both sides left the meeting with this issue unresolved and the future of the joint venture uncertain.

Over the next month, Harvey Kapnick continued to think about the plan and finally decided that a joint-venture business was not the best solution at all--a 100% sale and pure outsourcing agreement would be better for both parties. In an outsourcing partnership, CSC could purchase outright all of GD's IS facilities and business (except product-embedded technology development)[13] and then provide information services to them. This solution fit beautifully with Anders's corporate strategy--General Dynamics would get a large cash infusion from this sale, could divest a non-core business division (DSD), and would not have to worry about the future risks of being involved in a new non-core high technology business. Other GD top executives agreed with Kapnick that the better plan was an outsourcing agreement, and not a joint business venture.

According to Honeycutt,

> This looked great from our perspective: 100% ownership of an outsourcing business was much better for us than a joint venture with GD. We were trying to build a reputation as a commercial outsourcer. In retrospect, the last thing we needed was a joint venture with a government defense contractor. Acquiring GD's IS capacity would put us on the elite list of commercial outsourcers, and it could give us facilities that we could use to serve other commercial clients.

This change of mind-set sparked renewed interest in the negotiation, but the purchase price was still an unresolved issue. In order for this deal to go through, a purchase price for the business would have to be agreed upon, and then Hall, Feuerstein, and Honeycutt would have to work with CSC to put together a plan for outsourcing the Data Systems Division which could then be presented to the GD Board of Directors at their next meeting in August--less than two months away. If the Board approved the outsourcing concept, the two companies would then work to create a detailed contractual agreement.

At this point, Hall and Feuerstein had several critical issues on their minds: Clearly, the cash infusion generated by the sale of DSD would be very valuable to GD, but how much was "enough"? How much cash did they have to get for the sale of the DSD business to make the transaction worthwhile? In addition, the flexibility and savings afforded by outsourcing was a great advantage, but were the advantages of outsourcing worth the risks? How much cost savings should they demand? Or would it be enough for GD to pay CSC an amount equal to their own DSD charges for the benefit of cash and flexibility? How could GD maintain enough control over its information systems? How "operationally transparent" could this transfer be? How could they minimize the trauma to the organization and the people? How would employees be treated by this deal? Could they take their pensions, vacations, and fringe benefits with them as they transferred from GD to CSC? What would happen to the CSC contract in the future if GD decided, according to Anders's corporate policy, to divest any of its business units?

[13]GD's product-embedded hardware and software technology was never up for sale in this negotiation. This proprietary technology was crucial for GD's innovative product strategies. As such, this technology fell under the auspices of GD "product development," rather than "information services."

At the same time, Honeycutt had several critical issues on his mind: It was clear that GD wanted a significant cash infusion, but how much should CSC, a publicly held company, prudently pay for this business? This was a brilliant opportunity for CSC to leverage its strength in government information systems to enter the commercial market. The publicity from the deal would boost CSC's visibility in the commercial outsourcing market substantially. But how much was this opportunity really worth?

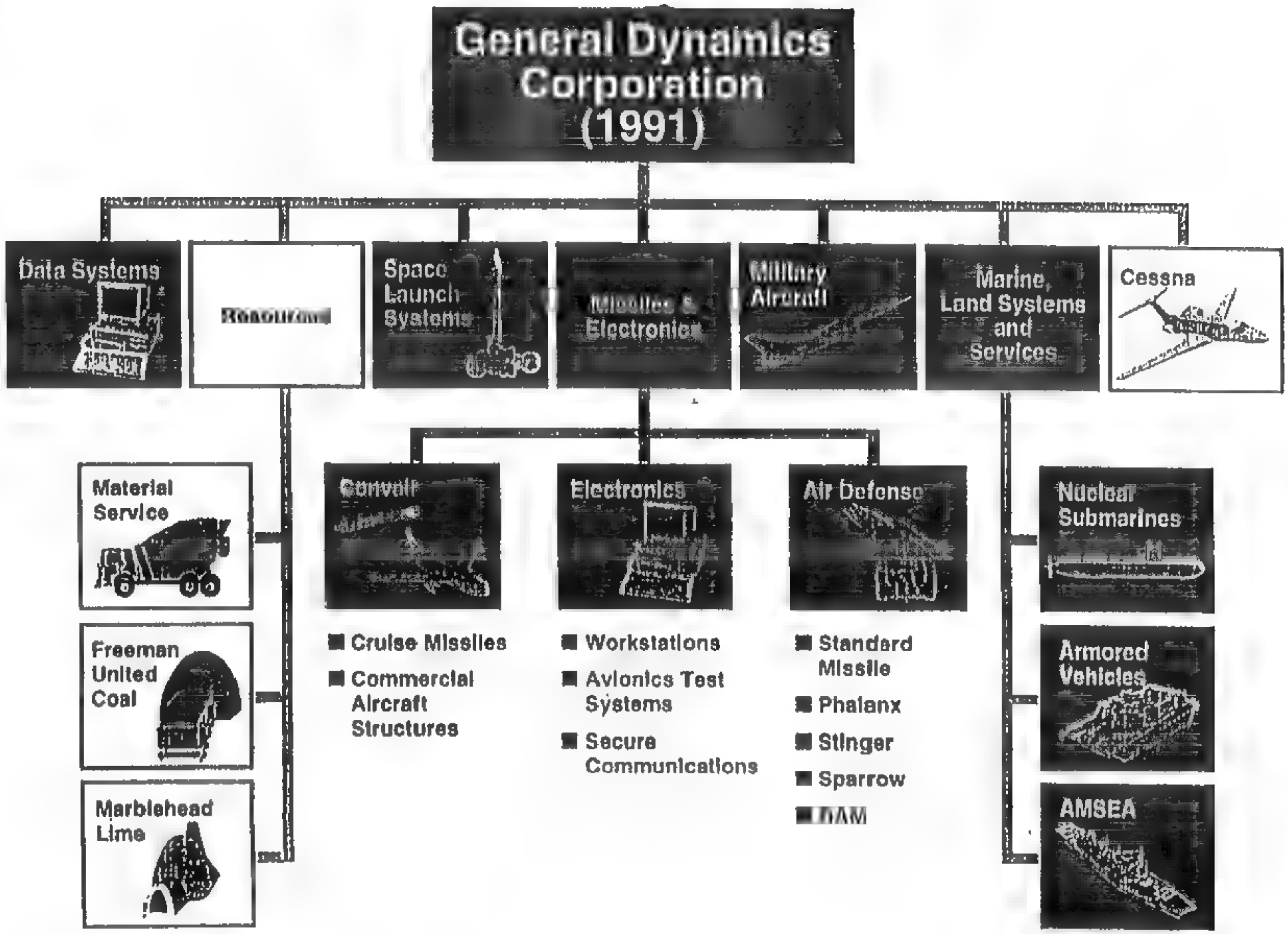
Equally important was the question of how much slack was in the Data Systems Division to be squeezed out while maintaining GD performance requirements. Could CSC make a healthy profit managing the organization?

An additional imponderable was how much excess capacity was in the DSD facilities for CSC to use serving other clients. Honeycutt expected that CSC could respond to General Dynamics requirements and still have resources available to attract and serve new commercial clients.

With General Dynamics's corporate strategy of "Buy, Sell, or Merge," Honeycutt was concerned with the future viability of an outsourcing contract if GD chose to divest any business units. How could a contract be structured to protect CSC if GD divested one of its business units in the future?

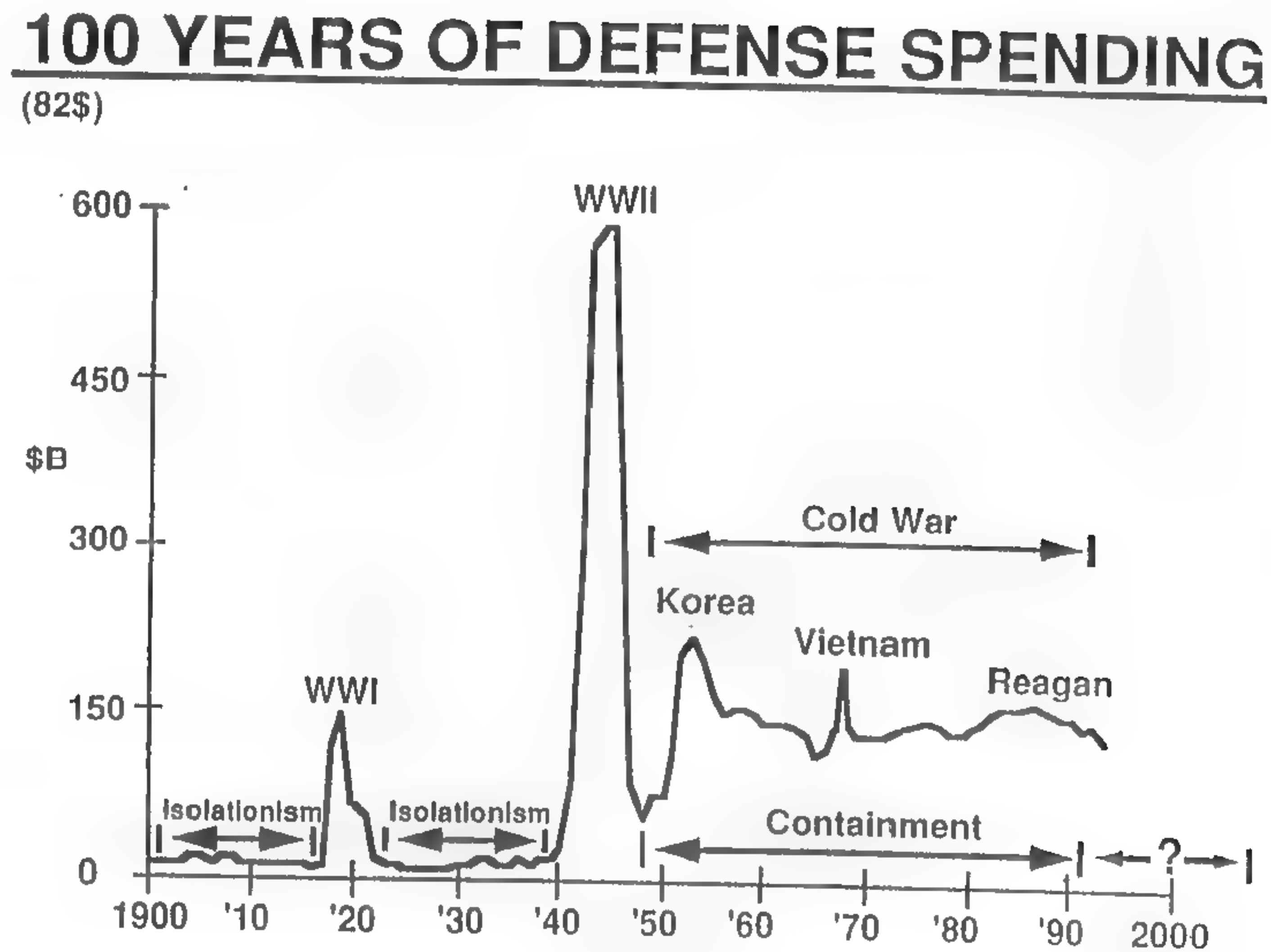
Finally, Honeycutt thought about the transfer of employees from GD to CSC. The expectation was that the professional IS staff would be happy to make the move to CSC because CSC could offer a better career path for IS professionals in a growth computer business than GD could offer in a declining defense market. These individuals had similar backgrounds and professional skills as CSC's own employees, and Honeycutt thought that in the future, they would even be able to move out into CSC's other units.

Exhibit 1 General Dynamics Divisions, 1991



Source: General Dynamics Company Records

Exhibit 2 100 Years of U.S. Defense Spending



Sourc. eneral Dynamics Company Records

Exhibit 3 General Dynamics Financial Highlights

General Dynamics Financial Highlights (dollars in millions, except per share and sales per employee amounts)

	1991	1990	1989
Summary of Operations			
Net sales[a]	$ 8,751	$ 9,457	$ 9,442
Operating costs and expenses	8,359	10,374	8,934
Interest, net	-34	-62	-73
Provision (credit) for income taxes	-43	-366	134
Earnings (loss) from continuing operation	374	-674	269
Net earnings (loss) per share			
Continuing operations[a]	8.93	-16.17	6.44
Discontinued operations	3.13	2.31	0.57
Capital expenditures[a]	82	306	411
Research and development[a]			
Company sponsored	162	353	438
Customer sponsored[b]	601	510	506
Total	$ 763	$ 863	$ 944
At Year End			
Total backlog[a]	$ 25,597	$ 22,151	$ 27,688
Shareholders' equity	1,980	1,510	2,176
Total assets	6,207	5,830	6,049
Number of employees	80,600	98,100	102,200
Sales per employee[a]	116,200	101,700	96,400
Other Information			
Purchases of property, plant, equipment	82	306	411
Depreciation, depletion, and amortization	303	370	352
Salaries and wages	$ 3,204	$ 3,433	$ 3,311

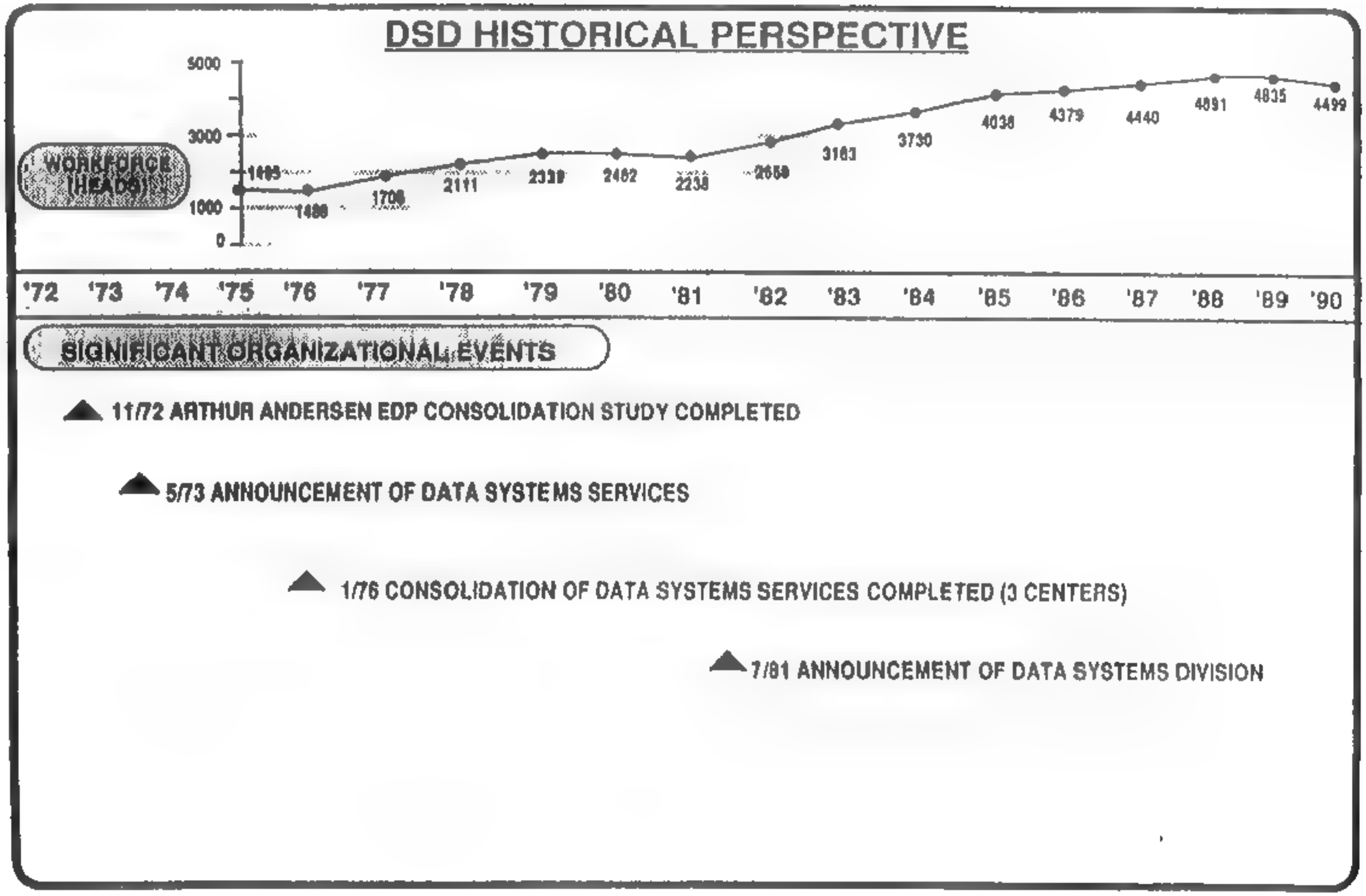
[a]Data excludes Cessna Aircraft Company.
[b]Data excludes A-12 R&D expenditures.

Exhibit 3 (continued) General Dynamics Consolidated Balance Sheet

General Dynamics Consolidated Balance Sheet (dollars in millions)

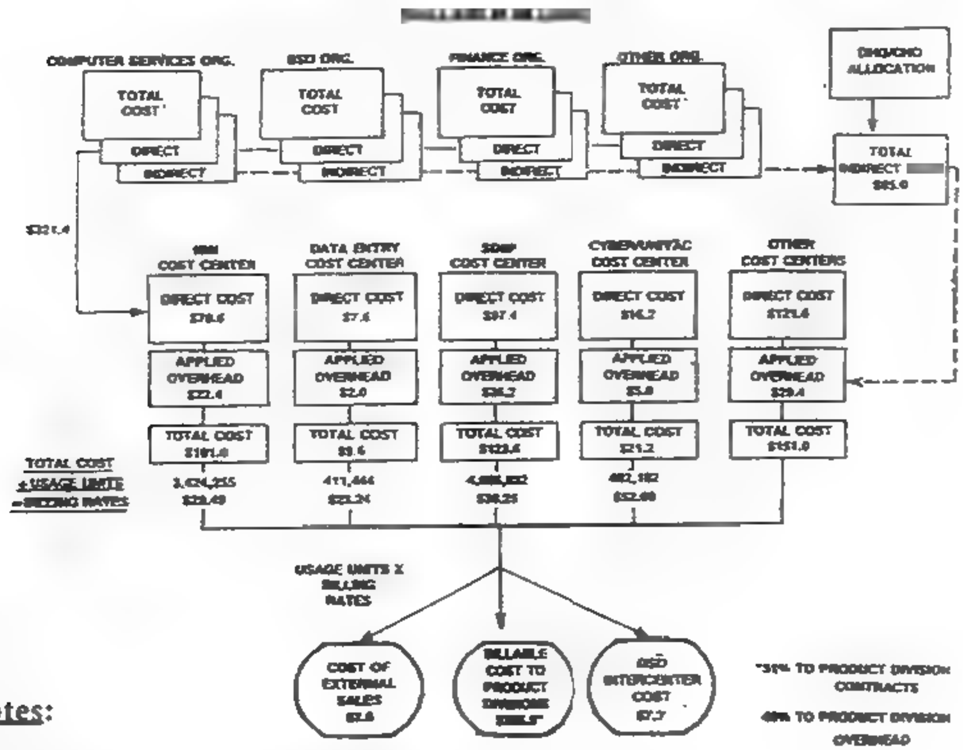
31-Dec	1991	1990
ASSETS		
Current Assets:		
Cash and equivalents	$ 513	$ 109
Marketable securities	307	-
	$ 820	$ 109
Accounts receivable	444	353
Contracts in process	2,606	2,843
Other current assets	449	288
Total current assets	$4.319	$3,593
Noncurrent Assets:		
Leases receivable-finance operations	$ 266	$ 287
Property, plant and equipment, net	1,029	1,411
Other assets	593	509
Total noncurrent assets	$1,888	$2,237
	$6,207	$5,830
LIABILITIES AND SHAREHOLDERS' EQUITY		
Current Liabilities:		
Current portion of long-term debt	$ 455	$ 1
Short-term debt-finance operations	61	65
Accounts payable and other current liabilities	2,593	2,279
Deferred income taxes	-	326
Total current liabilities	$3,109	$2,671
Noncurrent Liabilities:		
Long-term debt	$ 168	$ 619
Long-term debt-finance operations	197	264
Other liabilities	753	766
Total noncurrent liabilities	$1,118	$1,649
Shareholders' Equity:		
Common stock	$ 55	$ 55
Capital surplus	25	25
Retained earnings	2,651	2,195
Treasury stock	-751	-765
Total shareholders' equity	$1,980	$1,510
	$6,207	$5,830

Exhibit 4 General Dynamics DSD Historical Perspective



Source: General Dynamics Company Records

Exhibit 5 General Dynamics DSD Sample Cost Flow Chart (1987)



Notes:

Direct Costs are services directly consumed by GD business units.
Indirect Costs are DSD overhead costs.

The organizations across the top of the chart are departments of DSD which incur costs.

- The **Computer Services Org.** manages the computer utility
- The **Business Systems Division (BSD) Org.** manages Professional Services
- The **Finance Org.** managed DSD finances, and is considered an overhead department; it thus had "direct costs" of zero.

The middle portion of the chart shows various cost categories for billing purposes.

- The **IBM Cost Center** contains Computer Utility costs for GD business systems.
- The **Data Entry Cost Center** contains contains non-professional data entry services. These costs are rated by man-hour, in the same way as Professional Services.
- The **SD&P (Systems Development and Programming) Cost Center** contains Professional Services costs.
- The **Cyber/Univac Cost Center** contains Computer Utility costs for GD scientific and engineering systems.

The bottom of the chart shows the different consumers who are billed for DSD services.

- The majority of DSD services are used by **GD Product Divisions.**
  Of these billed costs, 51% were charged directly to government contracts; the remaining 49% were considered product division overhead. This 51% figure was very favorable by industry standards.
- DSD provided limited services to outside clients as **External Sales**, but these sales were negligible.
- **DSD Intercenter Costs** accounted for work done by one DSD data center for another DSD data center. It was an accounting elimination tool to eliminate double charges.

Source: General Dynamics company records

Exhibit 6 CSC Organization Chart

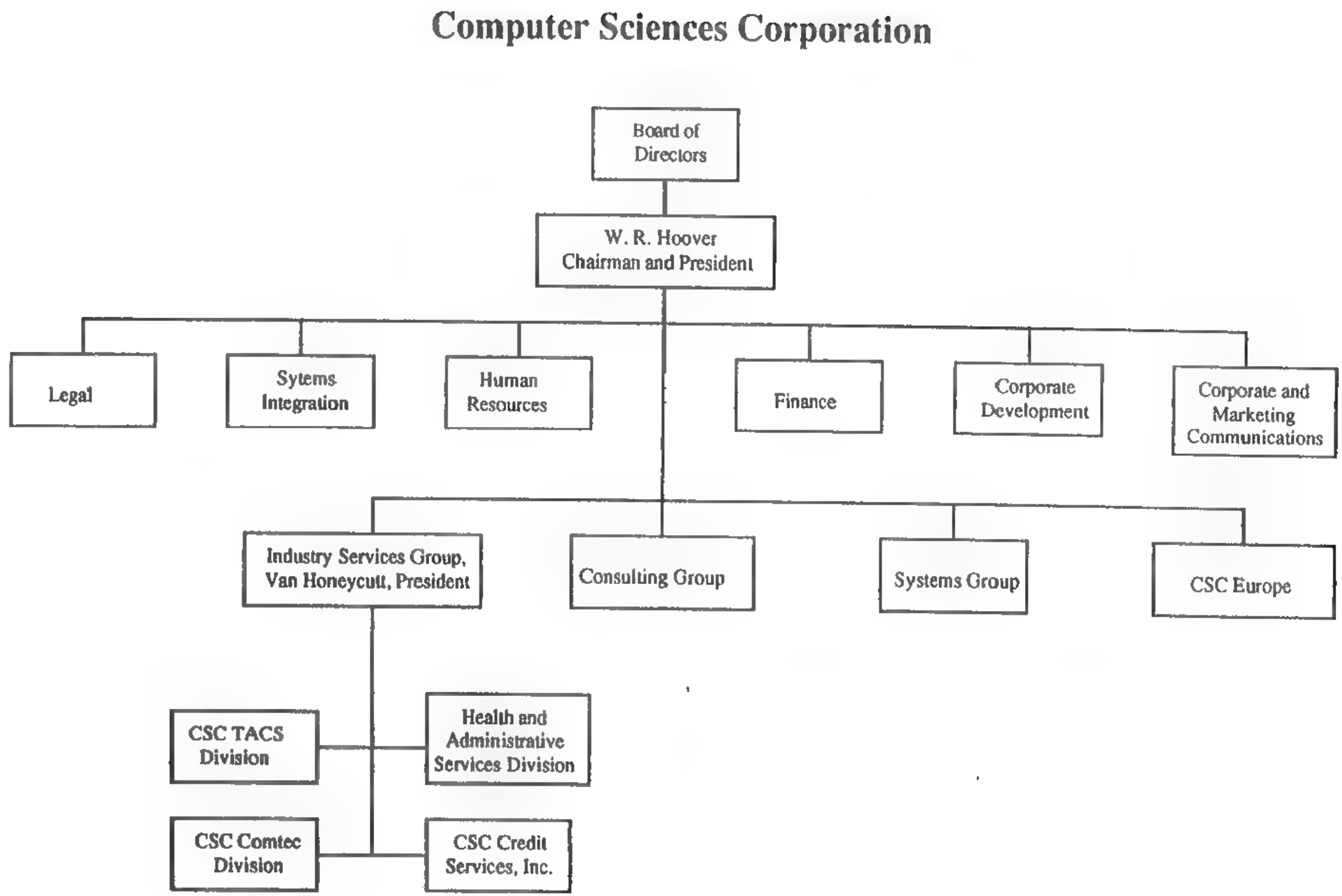


Exhibit 7 CSC Consolidated Balance Sheet

Computer Sciences Corporation—Consolidated Balance Sheet (in thousands except shares)

	March 29, 1991
ASSETS	
Current assets:	
Cash and cash equivalents (note 1)	$ 73,304
Short-term investments, at cost	63,674
Receivables	443,447
Prepaid expenses and other current assets	37,403
Total current assets	$ 617,828
Investments and other assets:	
Excess of cost of businesses acquired over related net assets	$ 174,689
Purchased credit information files	34,664
Purchased software	9,918
Other assets	35,235
Total investments and other assets	$ 254,506
Property and equipment-at cost	
Land, buildings and leasehold improvements	$ 92,520
Computers and related equipment	104,297
Furniture and other equipment	54,709
	$ 251,526
Less accumulated depreciation and amortization	117,039
Net property and equipment	$ 134,487
	$1,006,821
LIABILITIES AND STOCKHOLDERS' EQUITY	
Current Liabilities:	
Notes payable to banks	$ 28,864
Current maturities of long-term debt	3,828
Accounts payable	53,785
Accrued payroll and related costs	98,536
Other accrued expenses	56,611
Federal, state and foreign income taxes	113,339
Total current liabilities	$ 354,963
Long-term debt, net of current maturities	$ 108,867
Other long-term liabilities	$ 16,765
Total stockholders' equity	$ 526,226
	$1,006,821

Exhibit 7 (continued) CSC Statement of Earnings

Computer Sciences Corporation—Consolidated Statement of Earnings (in thousands except per-share amounts)

	Fiscal Year Ended		
	March 29, 1991	March 30, 1990	March 31, 1989
Revenues	$1,737,791	$1,500,443	$1,304,414
Expenses			
Costs of services	$1,436,052	$1,230,930	$1,067,189
Operating overhead	131,512	118,594	98,885
Depreciation and amortization	40,203	34,014	31,090
	$1,607,767	$1,383,538	$1,197,164
Operating income	130,024	116,905	107,250
Corporate general and administrative expenses	23,376	20,945	19,416
Other expense (income)-net	4,106	(7,240)	3,370
	$ 27,482	$ 13,705	$ 22,786
Income before taxes	102,542	103,200	84,464
Taxes on income	37,551	37,668	31,982
Net earnings	$ 64,991	$ 65,532	$ 52,482
Earnings per common share	$ 4.02	$ 4.07	$ 3.28

Exhibit 8 CSC Revenue Distribution

Computer Sciences Corporation—Revenue Distribution by Market

Fiscal Year	1991	1990	1989
Defense department	32%	35%	39%
NASA	14	16	17
Civil agencies	16	15	17
Total federal government	62%	66%	73%
Commercial	24	21	19
State and local governments	2	3	3
International	12	10	5
Total for continuing operations	100%	100%	100%

Revenues by Group

In millions	Federal Government	Commercial	State and Local Governments	International	Total
Fiscal 1991					
Systems Group	$1,029.9	$ 12.2	$ 0.6	$ 3.3	$1,046.0
Consulting Group	9.8	151.4	8.7	201.0	370.9
Industry Services Group	30.3	259.4	31.2		320.9
Total	$1,070.0	$423.0	$40.5	$204.3	$1,737.8
Fiscal 1990					
Systems Group	$ 952.5	$ 12.5	$ 0.7	$ 0.5	$ 966.2
Consulting Group	9.9	108.6	10.7	146.8	276.0
Industry Services Group	30.4	196.7	31.1		258.2
Total	$ 992.8	$317.8	$42.5	$147.3	$1,500.4
Fiscal 1989					
Systems Group	$ 863.9	$ 9.6	$ 3.9	$ 3.7	$ 881.1
Consulting Group	2.4	80.9	1.8	58.7	143.8
Industry Services Group	29.9	144.1	31.3		205.3
Continuing operations	$ 896.2	$234.6	$37.0	$ 62.4	1,230.2
Operations sold	25.2	32.9	0.1	16.0	74.2
Total	$ 921.4	$267.5	$37.1	$ 78.4	$1,304.4

Delaware Valley Financial Services, Inc.:

Managing the Customers' Perception Of Strategic Vulnerability

Eric K. Clemons

1. Introduction

"Did we even have a business plan? Of course! We must have had a business plan. . . . No, actually, we didn't have a plan at first. But we had such confidence and naïve enthusiasm that the leasing company assumed we knew what we were doing." Secure in her position as co-founder, President and Chief Executive Officer of Delaware Valley Financial Services, Inc., Lois Haber was able to laugh about the hectic days when she and her partner launched the company. "We got our copier. And we started our business."

Delaware Valley Financial Services is now a successful privately held mid-sized business located outside of Philadelphia. It is a leading third-party provider of support services for insurance companies that sell self-directed annuity products.[1] While not the largest firm in its industry, its officers believe that it offers the highest level of service to its customers, and to its customers' policy holders.

DVFS was founded in 1978, when the IRS challenged the legality of self-directed tax-deferred annuity products. The IRS ultimately lost in court, but the costs of defending itself and its product so exhausted the resources of First Investment Annuity Company of America, Inc. (FIAC), which had pioneered

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[1] Annuity products are retirement programs with deferred tax benefits, sold by major insurance companies. Self-directed annuities are those that allow the policy-holder to manage his or her own investments, and direct trading activities for the annuity, rather than allowing the plan administrator to hire fund managers to direct the investment portfolio.

these self-managed products, that it could no longer continue operations. It sold its operation to Life Insurance Company of North America, which simultaneously re-insured with SAFECO. SAFECO now was responsible for administration, and promptly discovered that it lacked the expertise to administer its new policies. SAFECO then hired Lois Haber and her partner, Drew Alloway, both formerly with FIAC, to provide administration services. Thus, DVFS was born.

Looking back, Lois noted, "We really knew how to manage the business and how to support the accounts. We figured, 'How complicated could it be to develop the software?' We had our first customer, and it needed our expertise and had no where else to go. We were in business."

2. Current Operations

DVFS provides a complete array of support services for five major insurance companies, and manages over $4 billion in assets for their holders of self-directed annuities. DVFS provides truly comprehensive service:

- DVFS issues customer policies and provides all service that the policy-owner requires, including annuity payments; this of course requires direct contact with the policy holder, and likewise requires that DVFS have information on each policy holder

- DVFS provides statement processing and trade confirmation

- DVFS manages the trading that the customer directs, and makes commission payments to the broker community

- DVFS is responsible for record-keeping and maintenance of archival data, and for state and federal filings; this record-keeping enables DVFS to maintain detailed profiles on the trading activity and cost of service of each account, even if this is not done at present

- Most striking, DVFS is even entrusted with performance monitoring and handling customer complaints about the quality of service they have received from DVFS

Of course, DVFS is almost invisible to the account holders of its customers. Its name appears on statements only in very small type. Telephone calls are answered using the name of the insurance company that sold the annuity, rather than using DVFS's own name (e.g., A.I.G. Annuities Administration. Good morning. How may I help you?"). Of course, this requires that DVFS maintain an array of 800-numbers, to identify in-coming calls and route them to the appropriate support desk.

DVFS is justifiably proud of their service quality. The house error account for 1992 showed a net trading loss of less than $350, an astoundingly low amount considering the value of the portfolio and the level of trading[2]. Still, it is quite striking that their customers are willing to let DVFS retain responsibility for operating their complaint desks and for monitoring service quality and satisfaction of policy holders. When questioned about the risk that her

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[2] In an average year, DVFS executes between 50,000 and 60,000 trades as directed by their customers.

customers are accepting, Lois responded with her characteristic good humor, but with brutal accuracy: "What risk? All they're risking is their reputations!" Clearly, customers are accepting a high degree of strategic vulnerability, and their perception of DVFS as a reliable and safe provider of services is critical.

The Company believes that it owes its current high degree of success to its commitment to quality and integrity, and to the economic advantages that its customers achieve from dealing with a third-party servicer with a larger portfolio base:

- It offers its customers quality of service in all aspects of their operations

- It enables rapid market entry to new competitors who wish to enter the business, and it provides its current customers rapid response to industry changes

- It offers new customers market entry at a known cost; likewise it offers its existing customers service at a known cost, and at a cost that is lower than customers can achieve for themselves

The first point is self-evident. The second suggests that while customers are unlikely to achieve a service advantage over their competitors who also use DVFS, they are assured that they will not be at a relative disadvantage. The third suggests that DVFS can provide service, even to industry giants, at a cost that they cannot match internally. While initially surprising, there is ample precedent for this. Merrill Lynch relied upon BancOne for initial operation of its successful pioneering ***CMA®*** (cash management account) product, while

most of their competitors relied on different outsourcers to provide a competitive response. Likewise, most banks in Philadelphia relied upon MAC, operated by Philadelphia National Bank, to enable them to respond rapidly to the first entry of Girard into ATM service.

DVFS also attributes much of its success to fairness in pricing. It has its own internal measures of customer profitability; when an account succeeds and grows with DVFS's assistance, DVFS's unit costs decline, and DVFS then negotiates the customers' unit prices for services down in response.

Of course, even in a successful, well-run business, with a commitment to fairness in pricing and to quality of service, accounts do leave. DVFS has, in its history, lost only three accounts. The first left because it stopped selling self-directed annuity products and its account portfolio became small enough to allow manual processing. The second grew large enough to desire to bring processing in-house. The third, a subsidiary of a manufacturing giant that decided to rethink its strategy of diversification and sell its part of its financial services and insurance operations, felt that it would be easier to sell this business if all processing and customer service were done internally. DVFS, in its contracts with customers, stipulates that customers own the data that DVFS processes for them, and that DVFS will provide conversion services to enable customers to bring operations back in-house. These conversion services are provided on a cost-plus basis, like the services that DVFS offers to tailor offerings to the specific needs and wants of major accounts; while they are modestly profitable, they were never intended to be major sources of profits for DVFS. In fact, the Company remains quite proud of an unsolicited letter it received from a former customer, commenting on the ease with which they were able to leave DVFS and internalize operations.

The Company has a high degree of expertise in reliable software and in operation of fault-tolerant database systems. Equally important, reflecting the unusual circumstances of the Company's origins, it maintains its expertise in legislation and tax rulings concerning its core business in tax-deferred annuities products.

3. Limitations

While the Company would of course like to increase its size, and thus its profits, it remains committed to only a rate of growth that will enable it to continue its high degree of service. At present it has no marketing or sales departments, finding that word of mouth and its reputation within the industry are adequate to sustain the desired rate of growth. And, while it maintains a high level of expertise in its core areas, it has no capability for direct marketing to policy holders who might wish to buy annuity products, nor in fund management.

Introduction to Self-Directed Annuities
Delaware Valley Financial Services
Supplement - Prof. Lorin Hitt

A self-directed annuity is an investment product sold by insurance companies to individual investors as a vehicle for retirement saving. The advantage of annuities is that interest and investment returns accrue tax free until money is withdrawn from the plan. Some classes of investors (e.g. teachers) in some programs can also make "pre-tax" contributions to their annuities, where the principal is only taxed on withdrawal as well. At retirement age, a person could either elect to receive the accumulated value in a lump sum (often incurring a tax penalty), or receive periodic (usually monthly) payments of a certain amount. Upon death, depending on how the annuity is structured, there may also be a death benefit paid to a person's designated beneficiaries.

Annuities have been a staple of insurance companies for many years. Traditionally, investors made contributions at a single period (single premium annuities) or on a regular weekly, monthly or annual basis as part of a payroll deduction. This money was invested by the insurance company and an investment return was credited to the account. The insurance company kept a portion of the investment returns to compensate them for administering the annuity, investing the money and often guaranteeing a minimum rate of return. One disadvantage of traditional annuities is that insurance companies had historically poor investment performance both because their investment operations were high cost, and also because they tended to invest very conservatively.

Self-directed annuities (or variable annuities) appeared as a way to keep the tax advantages of traditional annuities but obtain market returns on their investments. Investors were now allowed to allocate their investments to a variety of investment products, such as load-bearing mutual funds, insurance company investment accounts, certificates of deposit, etc. Insurance companies still earned fees from administration (usually as a percentage of assets or by flat fee) but were not solely responsible for investments. Self-directed annuities were substantially more complex than traditional annuities because the administrator now had to account for multiple investment holdings, credit commissions to brokers on purchases, maintain investors preferred investment allocation, switch investments between funds and interact with outside parties for investment services.

Day-to-day operations for an annuity business fall into several categories:

· *Account setup*. Personal and financial information needs to be entered into the system and maintained for the life of the annuity. Original documents need to be kept.

· *Account maintenance*. Information on customers needs to be updated such as name, address, employer, and the names of beneficiaries. In addition, the administrator needs to maintain investment preferences (e.g. allocate 30% to Vanguard Index Trust and 70% to the insurance

general account), process fund transfers between investments and enter daily investment performance information (received from brokers) into the system to calculate account balances.

· *Reporting*. The administrator needs to produce monthly statements for customers, and accounting statements for insurance companies and brokers. In addition, a variety of tax documents need to be prepared for the customers and the IRS

· *Payment receipt*. The administrator needs to receive payments and make sure they are credited to the appropriate investment and customer accounts. The administrator is responsible for the financial impact of any errors.

Payment disbursement. For annuities that are now making payments to customers, the administrator generates monthly checks to customers and associated tax and accounting documentation. The administrator is also responsible in some cases for paying brokerage fees, making death benefit payments and generating checks for customers that are withdrawing the full amount of their accounts.

Also note that while tax regulations and industry practices place some constraints about how annuities are structured, an individual company may offer multiple products and companies may structure their products differently.

Procter & Gamble: Improving Consumer Value Through Process Redesign

Procter & Gamble Worldwide (P&G) is one of the largest manufacturers supplying grocery retailers and wholesalers and a leader in designing how branded consumer-goods manufacturers go to market. P&G's process innovations are driven by its focus on improving consumer value by eliminating nonvalue-added processes in the channel. Changes at P&G in organization, systems, procedures, and policies affected both the company and the entire channel. These changes were governed by the recognition that manufacturers, distributors, and retailers have to cooperate in creating industrywide approaches to drive inefficiency out of the grocery distribution system.

Many changes leading to organizational and channel transformation were initially viewed as information systems innovations (e.g., developing systems to automate existing practices). Breakthrough change came with the realization that the success of P&G brands depended on eliminating all processes that didn't deliver value to brand- loyal consumers. The promotional frenzy of the late 1970s and 1980s that characterized the retail industry had produced a backlash among brand-loyal consumers, who felt they weren't getting fair value day-in, day-out. P&G studies showed that less than half of their promotional dollars were passing through to the consumer and that swings in price were creating variability and massive inefficiency, not only in P&G's manufacturing and distribution systems but throughout the entire grocery supply chain.

As a result, P&G redesigned how it went to market as a branded consumer-goods maker. Its actions fell into two broad categories: participation in industrywide efficiency improvements, and pricing policy changes, both necessary to improve the value of its brands. As its new pricing strategy was implemented, P&G also took a leadership role in working with the grocery industry—including other manufacturers—to significantly accelerate the adoption of more efficient systems, policies, and practices in the grocery channel (**Exhibit 1**). These industrywide changes resulted in dramatic improvements in P&G's and retailers' effectiveness in delivering value to the consumer.

Research Associate Theodore H. Clark prepared this case under the supervision of Professor James L. McKenney as the basis for class discussion rather than to illustrate either effective or ineffective handling of an administrative situation.

Company and Industry Background

P&G's sales of $30 billion in 1993 were evenly divided between the United States and the rest of the world. P&G had developed a reputation for aggressive and successful "world-class" development and marketing of high- quality consumer goods over more than 150 years of operations. Throughout its history, the company focused on providing superior performing brands that gave consumers good value.

P&G's post-World War II growth came from three sources: acquisitions, development and marketing of new brands, and international expansion. Its acquisitions included: Duncan Hines and Hines-Park Foods (food products), W. T. Young Foods (peanut butter and nuts), J. A. Folger (coffee), and Clorox Chemical Co. (bleach). In 1957, the U.S. Federal Trade Commission (FTC) sued P&G to force the divestiture of its Clorox subsidiary. This effectively terminated the growth by acquisition strategy for two decades, forcing P&G management to grow through new-product development and international expansion.

P&G's international strategy was to take core U.S. businesses—soap, toothpaste, diapers, and shampoo—and replicate them to the rest of the world. International sales increased from virtually zero in 1953 to $4 billion in 1985. During this expansion period, new geography was conquered for existing brands, and P&G rotated managers to different locations between the U.S., Europe, and Asia. During the 1980s, P&G international shifted to developing and marketing products tailored to the needs of each market. This increased focus on understanding and meeting consumer needs worldwide enabled P&G to expand international from about $4 billion (31% of sales) in 1985 to $15 billion (50% of sales) in 1993. Ed Artzt, president of P&G International from 1983 to 1990, was appointed CEO of the company in 1990.

By 1993, P&G's product lines included a wide assortment of products, with the company organized into five product sectors: Health/Beauty; Food/Beverage; Paper; Soap; and Special Products (e.g., chemicals). Each sector was organized into product categories, and each category was responsible for a group of brands. Most new-brand introductions were based on improvements or extensions of existing products. Several new products, such as Pampers disposable diapers and Pringles potato chips, were developed to meet basic consumer needs not yet served by existing products. Extensive market research, low-cost and effective advertising, and aggressive R&D investments enabled P&G to increase sales in the U.S. market from $1 billion in 1955 to almost $9 billion by 1985.

Competition for most of P&G product categories was concentrated, with two or three branded product producers controlling more than 50% of total branded product sales in each category. This concentration for the top three brands in any product category was typical for other manufacturers as well, although increasing sales of private- label products were eroding market share for the major brands in some categories. For some products, such as soaps or diapers, P&G and one competitor controlled more than 70% of the market. The strong consumer pull for P&G products provided the company with an advantage in dealing with retailers and wholesalers.

P&G products were sold through multiple channels, with grocery retailers, wholesalers, mass merchandisers, and club stores the most important in product sales volume. While relationships with retailers and wholesalers had not always been harmonious, P&G management recognized the need to serve the needs of both the consumer and the channel in order to be successful in the market. Demand for P&G products was primarily driven by pull through the channel by end consumers, rather than by trade push, with the trade frequently carrying P&G products because of consumer demand and competitive necessity rather than due to the trade's strong loyalty to P&G as a channel partner. Relationships between P&G and the trade through 1980 had primarily been

based on negotiations over short term initiatives and promotions. Increased use of promotions was part of the trend during this period, with P&G competing with other manufacturers for retail shelf space and promotional displays through various types of periodic promotions. Forward buying of promoted merchandise by 1985 had become the norm of the industry, with many brands stocked with over three-months' supply.

Pricing and Promotions

Product promotions had existed to a limited extent for decades but expanded dramatically during the 1970s, partly due to President Nixon's imposition of price controls in 1971 as part of an attempt to reduce inflation. The combination of high inflation, relatively low interest costs, and large promotional discounts made the economics of forward buying very attractive for chains. Product procurement cost depended upon so many different allowances and other incentives provided by manufacturers that the actual cost of a single product at any one time on the shelf was impossible to determine. Inability to understand costs and the discounts and allowances available from aggressive purchasing resulted in a focus in the channel on "buying for profit" rather than "selling for profit."

This reliance on a multitude of promotional programs coupled with forward buying increased retailer inventories and required manufacturers to also maintain large inventories in order to be able to meet the high demand artificially created by forward buying during these promotional periods. Variation in consumer demand was increased by store promotions, and variation in manufacturer demand was further increased by retailer forward buying activities, making changes in demand difficult to forecast accurately for manufacturers. This uncertainty about total demand and large fluctuations in periodic demand not only increased manufacturer inventory requirements but also resulted in higher manufacturing costs than would have been possible in a direct pull through demand environment.

One of the objectives of channel-transforming innovations in the 1990s was to develop more collaborative and mutually productive relationships with channel partners, replacing negotiations with cooperative efforts to better serve consumer needs efficiently. By combining consumer loyalty with improved channel efficiency and relationships, P&G believed that market share for P&G products would increase and the cost to serve the channel and the end consumer would decline, enabling all members of the channel to benefit.

Retail Distribution Channels

Retail grocery was the most important channel for the sale of P&G products and consisted of manufacturers, distributors, and retail stores (**Exhibit 2**). Approximately half of all retail grocery sales volume went through chains of stores which provided their own distribution and warehousing of products, and half through wholesalers who primarily served small chains and independent retail stores.

Profit margins for grocery retailers were low, typically 1-3% of gross sales before tax. With low unit prices and high volumes, store operating profits were highly dependent on providing efficient operations. Total sales volume per store and per square foot of retail space were critical factors influencing retailer profitability. Since advertising was a significant cost for most retailers, regional market share was a critical factor influencing retailer profitability by leveraging the fixed costs of regional (e.g., newspaper) advertising.

Mass-merchandise (e.g., Wal-Mart) and club-store (e.g., Sam's Club) retailers supplied a limited assortment of P&G and other grocery-channel products at low margins, enabling them to offer attractive prices to consumers. These formats grew rapidly during the 1980s. Even though club stores offered a limited product selection and provided less service than traditional grocery retailers, a significant segment of consumers was willing to replace grocery-store shopping with club-store purchases, with the attraction of lower prices at the club stores more than offsetting the inconveniences involved. A McKinsey study of alternative distribution channels for grocery products, published by the Food Marketing Institute in 1992, demonstrated that the more efficient distribution and merchandising of these alternative formats enabled them to offer lower prices to consumers than traditional grocery retailers. This study served as a wakeup call to the grocery industry, suggesting that existing processes needed to be improved to enable it to meet the challenge of these rapidly growing alternative formats.

Improving Channel Efficiency and Service

In the mid-1980s, P&G management launched several projects to improve service and reduce costs across the channel. The first effort focused on improving supply logistics and reducing channel inventory via a process that eventually was called continuous replenishment (CRP). The second was a project to revise the ordering and billing system to improve total ordering and service quality for channel customers.

The Early Logistics Improvement Trials

In 1985, P&G tested a new approach to channel logistics for replenishment ordering with a moderate-sized grocery chain. This test involved using electronic data interchange (EDI) to transmit data daily from the retailer to P&G on warehouse product shipments to each store. P&G then determined the quantity of products to be shipped to the retailer's warehouse by using shipment information rather than shipping based on retailer-generated orders. Product order quantities were computed by P&G with the objectives of providing sufficient safety stock, minimizing total logistics costs, and eliminating excess inventory in the retailer's warehouse.

The results of this initial trial were impressive in inventory reductions, service level improvements (e.g., fewer stockouts), and labor savings for the retailer. Besides other savings, the retailer was able to eliminate several buyer positions through this process restructuring. However, the benefits for P&G were unclear, and the new ordering process was more costly for P&G than the old one where the retailer determined order quantities.

The second test of the new ordering process was with a large mass merchandiser. In 1986, P&G approached this retailer's management with a proposal to dramatically change the way diapers were ordered and distributed in an effort to reduce retail store stockouts, lower product acquisition costs, and minimize total inventories. Limited warehouse capacity forced the retailer to purchase P&G diaper products in small quantities to be delivered directly to each retail store. Retail stores had frequent stockout problems, and the cost of these small orders delivered directly to the store was high for both P&G and the retail chain. Diapers were an important product category for this retailer, and it wanted to price diapers lower than other retailers in their markets. Unfortunately, the distribution system used for procurement resulted in higher acquisition cost for diaper products than many of its competitors (e.g., supermarkets), who were able to order in truckload quantities.

P&G proposed that the retailer inventory diaper products in the chain's distribution warehouse, provide P&G with daily data on warehouse orders received from the stores, and allow P&G to use the daily warehouse shipment data to determine warehouse replenishment volumes needed. This new replenishment process would limit the retailer's warehouse inventory to acceptable levels, eliminate costly LTL (less-than-truckload) shipments, and reduce stockouts for retail stores. Both P&G and the retailer would benefit by reducing costs and increasing sales. Sales increases would result from lower retail prices enabled by lower costs and from providing better service to consumers through greater product availability.

The new replenishment process resulted in substantially lower product acquisition costs through truckload volume purchases, enabling lower retail pricing. Without increasing inventory levels or stockouts, the retail chain was able to expand P&G's diaper SKUs in the stores. The combination of lower prices, reduced stockouts, and expanded SKUs in the stores dramatically increased P&G's diaper sales through this retailer's stores. This new process represented a major change in channel ordering and logistics and established the basic principles of what eventually became known as CRP (continuous replenishment program). This second trial demonstrated the potential for logistics innovations to offer mutual benefits to retailers and manufacturers by reducing channel costs and increasing consumer sales.

In early 1988, top executives from P&G and another mass-merchandise chain met to discuss ways to improve logistics in the channel. The retailer was warehouse constrained due to rapid growth and was relying heavily on costly LTL shipments to meet demand. LTL shipments were expensive for both partners, and made it difficult for the retailer to increase diaper sales. During the meeting, the CEO of the mass-merchandise chain suggested that P&G simply ship products on a just-in-time basis when needed using the retailer's actual sales data. Deals and promotions would be replaced by a constant allowance that resulted in an equivalent net-price for the retailer to remove forward-buy incentives.

A multifunctional team worked together for the rest of the conference to work out many of the details of implementing the new process. With top executives from both companies committed to rapid adoption, and building on P&G's experience with two other retailers, implementation of CRP took less than two months in total. In April 1988, P&G began shipping products based on retail demand data, placing orders automatically for the retailer. Information on demand was transmitted via fax and phone until EDI links were established.

Expanding the CRP Innovation

The success of the CRP program with leading mass-merchandisers generated interest from other retailers in the new process. By 1990, most large mass-merchandisers had fully implemented CRP. In 1990 and 1991, three grocery chains adopted CRP with P&G, and the innovation proved highly successful in reducing inventory and stockout levels for these early grocery pioneers. CRP adoption started with diapers and then expanded rapidly to other products as the potential for mutual cost reduction was demonstrated across the channel. CRP's success with early partners led the head of the diaper product group to commit $1.5 million in development funding during 1991 to expand the initial CRP system into a more robust production system that could be expanded to as many customers as needed. The increased sales and profits from the initial adopters of CRP were enough to justify the entire development cost being funded by this single product category!

The diaper product group then used CRP as a tool in selling an expanded diaper product line (boy and girl diapers) to retail chains. The new product line doubled the total number of SKUs in an already crowded product category but was needed to better respond to customer needs and meet competitive pressures. CRP enabled the diaper product sales force to offer customers a solution that

managed the increased number of SKUs while reducing both inventory levels and stockouts for the retailer. Since a barrier to expanding product SKUs was the resulting increase in inventory required, CRP proved helpful in marketing the new diaper product line.

During 1992, 14 additional grocery chains implemented CRP with P&G, and existing CRP customers continued to expand CRP usage to new product lines. During 1993, an additional 15 new grocery chains or divisions of grocery chains adopted CRP. By July of 1994, a total of 47 channel customers had adopted CRP with P&G, and more than 26% of P&G sales volume was ordered via CRP. As these customers expanded use of CRP to new product lines and across multiple distribution centers, total CRP demand from these customers alone was expected to increase to 35% of P&G sales by the end of 1994. Ralph Drayer, VP of customer services, expected use of CRP to reach 50% or more of total US product shipment volume by the end of 1995.

Increased retail sales were an important benefit of the CRP program for P&G and its distributors. Sales of P&G products through CRP retailers increased 4% more on average during 1993 than sales through non-CRP retailers. Although some of this difference could be attributed to faster-growing retailers adopting CRP, Drayer believed that some of the gain was due to sales gained from competing products due to reduced stockouts, lower retail pricing, and expanded product selection in the store. However, even if only 1% of the 4% sales increase was due to competitive share gains, this represented a huge competitive and economic gain for P&G. One food division manager said he would "gain more market share by expanding CRP than through [product] line extensions."

The Role of EDI

When P&G began expanding the use of EDI with retailers to improve ordering efficiency, problems with order quality increased significantly. The sales representative or customer service representative in the manual process was often able to catch some of the problems and manually adjust retailers' orders to work in the P&G systems. Some of these adjustments later resulted in errors in the collections phase, but at least the order was entered and shipped. Removal of this human buffer created problems for most EDI orders could not be processed without manual intervention. These early EDI trials with customers increased costs for P&G instead of providing savings since most orders had to be manually reworked and rekeyed into the OSB system. Without process redesign, using EDI for ordering offered little benefit for P&G or customers, although it did highlight problems and misunderstandings.

EDI represented an important part of P&G's strategy to improve the efficiency of the ordering process and was essential for CRP implementation, but EDI alone was not viewed as particularly important in the effort to improve efficiency and order quality. One P&G manager described EDI as "an enabling technology" that, if implemented without changes in Interorganizational processes and policies, represented little more than "a fancy electronic fax." Another manager explained: "EDI is simply an electronic envelope, not a system. It does not fix anything and, by itself, is not a solution. However, when implemented in parallel with process and systems reengineering, it can become a powerful tool."

An important role for EDI at P&G was to provide an essential platform for CRP operations. One manager described CRP as "two-way EDI with tight links into the systems of both companies." Of course, CRP required more than system changes, but the degree of interconnection with the systems of each organization was much tighter with CRP than was required for EDI with non-CRP customers. This linkage between systems across the two companies, enabled by the EDI link, resulted in error-free interchange of large amounts of data automatically between the companies. CRP dramatically increased the amount of data shared by companies in the channel, which made

EDI essential for effective operations. Although early CRP trials had used fax and phone for data transmission, several P&G managers expressed the view that CRP without EDI was not viable:

The problem [with manual entry of data] is that any error would probably result in an out-of-stock condition. The risk of [data entry] keying errors in an non-EDI environment is just too great. You also have a lot of data that need to be entered, which would require extensive manual support. CRP without EDI is just not viable.

EDI offered companies economic benefits by reducing transaction costs, which encouraged EDI adoption, even without making the commitment to CRP. Although the potential benefits from CRP were much larger than the benefits from EDI ordering alone, the challenges in shifting to CRP were greater than many retailers were willing to face. EDI provided an easy first step for companies that wanted to be technologically prepared for the new era without committing to the management and policy changes required to implement CRP.

Drayer observed that successful implementation of CRP required both senior management commitment to the innovation and a relationship of trust between management at the two organizations linking their systems:

> Companies that have made the choice to be interdependent will move to CRP. You can't remain independent with CRP. . . . This is not something you can just connect between customers and suppliers. You need to understand the management changes required.

The Ordering, Shipping, and Billing Systems

In 1987, P&G management approved a major rewrite of the entire ordering, shipping, and billing (OSB) system, which took several years and cost tens of millions of dollars to complete. The systems in use at the time had been developed during the 1960s and had been upgraded many times. The batch processing system was both inefficient and ineffective; upgrading it was considered a competitive requirement for P&G to be able to provide the level of service required by customers. The OSB system supported all P&G activities in serving channel customers, including pricing, ordering, shipping, invoicing, and separate credit systems. The OSB project integrated many separate systems that did not work well together across functions and product sectors, enabling P&G to improve consistency and overall service levels.

The charter of the OSB development team was to understand how the business worked and then to automate the existing processes with sufficient flexibility to meet the various needs of the different sectors and functions. In some cases, standardization was allowed to simplify design and improve practices to a common level across the organization. The system absorbed a lot of the complexity of the existing processes which contributed to the cost of development, and was designed to eliminate manual processing steps but not to redesign the existing processes.

The rewrite of the system and the simultaneous upgrade of the hardware infrastructure were necessary but significant additional performance improvement opportunities remained because of complex pricing and promotion practices. The process and performance levels in 1988 (prior to OSB rewrite) are shown in **Exhibit 3**, with comparable data for 1992 (after OSB rewrite) shown in **Exhibit 4**. Invoice deductions by customers were still quite large in 1992, although the new system had helped some in this area. Although the new system did improve order shipment quality, problems with the existing pricing and promotion policies and processes still created deductions. It was clear that the front end of the OSB system, which involved pricing and promotions policies, needed to be revised.

Redesigning the Complete Ordering Process

P&G managers realized they needed to improve the total ordering process, starting with pricing policies and practices. Improving ordering quality required a simpler pricing structure that customers could both understand and track in their systems. A new pricing structure, introduced by Durk Jager, EVP responsible for all U.S. operations, dramatically simplified expansion of the new OSB system capabilities and represented a significant change in corporate strategy and policies. Pricing policy changes were critical for improving consumer value and building brand loyalty and facilitated expansion of the OSB systems to allow improvements in billing accuracy and reductions in invoice deductions. The combination of pricing policy changes and systems improvements benefited both P&G and channel customers.

The standardization and simplification of processes and policies across the organization accelerated under the leadership of Artzt and Jager. Challenging traditional practices and policies became acceptable and welcome, as long as suggested changes could be shown to improve consumer value by eliminating processes or costs that did not add value to the channel or products. One manager observed:

Jager made it okay to make change happen faster. The ideas were bubbling in the organization and the pace of change accelerated dramatically.

Redesigning the ordering process involved a combination of systems and business process changes which had to be carefully integrated. A key element of the new ordering process was the development of common databases for product pricing and product specifications. This shared vision of business simplification and a common database was solidly grounded in the philosophy of "simplify, standardize, then mechanize." The common databases developed to support simplified pricing were designed to provide data directly to the customer's own system electronically. This resulted in dramatic reductions in invoice deductions for retailers using the new pricing database to verify or confirm purchase order information.

The combined changes in systems strategy, organization, and policies resulted in a dramatic improvement in total order quality at P&G (**Exhibit 5**). Billing errors decreased by more than 50% from 1992 to 1994, and the percentage of billing disputes resolved in P&G's favor increased by more than 300% during the same period. The first-year savings from increased collections on invoices alone were enough to pay for the entire cost of development of the new pricing systems. P&G's customer teams were also able to concentrate on providing better service and marketing new products instead of spending time resolving billing problems. P&G's redesign of the total ordering process required fundamental changes in its structure, policies, and systems but yielded dramatic benefits in cost reduction and quality improvement. In addition to reducing invoice deductions, the redesigned business process allowed P&G to reduce costs throughout the entire ordering process.

Radical Restructuring of Pricing

The long-term strategic goal of increasing consumer value and brand loyalty, CRP's need for simple and stable pricing, and the need to reduce pricing complexity to improve quality in the ordering process all supported the decision to replace existing pricing structures with a simplified "value-pricing" program. This new pricing program was introduced initially for dishwashing liquids, where this new pricing approach was accepted, generally without much resistance. As the pricing change became accepted generally, although not universally, value pricing was gradually

implemented for more products (**Exhibit 6**). By late 1993, almost all P&G products were on some form of value-pricing plan.

The shift to value pricing represented a radical change in policies and was driven mostly by concern that frequent and complex promotions were eroding the value of P&G's brands. Brand loyalty declined in the United States during the 1970s and 1980s, due to the wild price swings that came with constant promotional activity. Frequent promotions rewarded only those consumers most sensitive to price and acted as a disincentive to brand-loyal consumers. Value pricing eliminated incentives for retailer forward buying and essentially offered constant procurement costs combined with some flexible allowances or funds provided for retail store promotions.

Value pricing offered important benefits for CRP customers, encouraging increased CRP adoption. Implementation of CRP with the first few customers required prototyping new net-pricing terms that eliminated variable discounts and promotions in order to remove incentives for forward buying. There was little benefit in trying to improve channel logistics efficiency while using a pricing structure that encouraged inefficient purchasing practices (e.g., forward buying). Until P&G restructured pricing, efforts to extend CRP were constrained because it lacked a standardized pricing structure that would eliminate forward-buying incentives.

Implementation of value pricing reduced the number of pricing changes at P&G from 55 per day in 1992 to less than 1 per day in early 1994. In July 1994, all remaining variable promotional allowances were eliminated for the last few product categories using these incentives, and geographic pricing differences were eliminated as well. Temporary price reductions or special promotions were allowed only to meet significant competitive threats to P&G brands, and they had to be approved by Jager.

There was considerable resistance to the change in pricing philosophy from some P&G senior managers, in spite of the obvious advantages, since this was completely the opposite of the high-low pricing strategies many executives had used to create new brands and strengthen P&G product market throughout their careers. Jager noted that the new pricing did cost P&G sales over the period, but that this incremental revenue actually cost P&G more to generate than the income created by the promotions. Thus, while sales were lower than would have been possible using promotional pricing, profits were stronger, and the company was better positioned to build a future based on value-priced products for brand-loyal consumers.

Leading the Grocery Channel Transformation

Working with retailers, wholesalers, other manufacturers, industry trade associations, and consulting firms, P&G participated in the development of the Efficient Consumer Response (ECR) vision of channel innovations that would enable grocery chains to compete effectively with low-cost alternative retail formats. ECR became a banner for a wide variety of innovations in the grocery channel that would improve efficiency (**Exhibit 1**). Various joint industry ECR committees were established in a coordinated effort to explore opportunities for channel process improvement.

CRP was an important element of the ECR vision. The ECR report by Kurt Salmon Associates, published in January 1993, suggested that 38% of the $30 billion in savings projected from implementing ECR in the grocery industry could be realized through more efficient replenishment ordering. Many grocery channel members were able to realize significant savings immediately by adopting CRP without waiting for the remainder of the ECR proposals to be fully

developed. P&G was a clear leader in the implementation of CRP and other ECR programs and wanted to increase the pace of ECR and CRP adoption in the industry overall.

The Change from Brand to Category Management

In the late 1980s, P&G management made a significant change in its brand management structure to improve coordination and efficiency. Multiple brands were combined into product categories, under the responsibility of a category manager, who managed individual brands as part of the overall category portfolio. For more than 50 years, the brand management approach had served P&G well, and the company had been recognized as the benchmark for excellence in brand management. The introduction of category management was a dramatic shift for a company that had pioneered brand management in the 1930s.

The category management approach provided more flexibility in restructuring the P&G product line. Brand restructuring or consolidation would have been more difficult to achieve under the prior structure. Brand managers maintained responsibility for advertising and limited promotional programs, but category managers established overall pricing and product policies, which enabled P&G to eliminate weaker brands. For example, the elimination of the White Cloud brand by merging the product into the Charmin line would have been resisted by a White Cloud brand manager but was strongly supported by the toilet-tissue category manager, who reported to the paper products sector manager. Category management also avoided conflicts between similar branded products in the same channel for advertising and distribution resources.

The shift to category management was consistent with the company's efforts to simplify and standardize operations and product lines. Many unnecessary SKUs were eliminated when SKU differences did not provide significant incremental value to the consumer. At the same time, new SKUs were added as new products and innovative extensions of existing product lines were developed. In total, the number of SKUs P&G offered remained about the same during the early 1990s, but the restructuring of SKUs provided consumers with greater choice of products that were specifically tailored to their needs, and eliminated a proliferation of product variety that was based simply on labeling or packaging differences.

Manufacturing and Planning Improvements

Although the initial benefits of CRP were reductions in inventory, stockouts, and handling and transportation costs, increased adoption of CRP by P&G customers offered dramatic cost saving opportunities for production and raw-material purchasing. P&G managers estimated that at least 10% of the cost of production for paper products was the cost of excess capacity required to handle product demand variations. Value pricing reduced demand uncertainty by eliminating forward-buy distortions, and CRP further reduced demand uncertainty and allowed almost instant feedback on demand resulting from product innovations or pricing changes.

The potential benefits of CRP for production cost and inventory savings were quite large. Savings in inventory or production were not automatic, but the shift to a more stable environment enabled P&G to negotiate more attractive pricing with suppliers and to use internal production capacity more efficiently. In some cases, the efficiency gains from value pricing, rationalized product lines, CRP ordering, and dramatic improvements in process reliability resulted in sufficient excess production capacity to eliminate entire production plants. During the 1990s, many P&G plants were expected to close as a result of improved operations due to the new policies and processes. In 1993, P&G took an extraordinary charge of almost an entire year's profits to reflect the

actual and expected costs of closing unneeded plants and reducing total employment levels for the company (**Exhibit 7**).

The CRP savings for diaper production were estimated based on experiences of multiple plants with different levels of CRP ordering by customers. The results of this analysis are shown in **Exhibit 8** and represent the early results of CRP adoption on the production process. Paper product managers believed that further costs savings could be realized as P&G teamed to better use the improved information about demand that was available through CRP ordering data. Through more effective negotiating with vendors and better use of actual demand data for planning and scheduling, additional savings could be realized in production.

Customers and Category Management

The second most important aspect of the joint industry ECR vision was the retailers' shift from buyers to category managers that was taking place among leaders in the industry during the early 1990s. Although the cost savings from this shift were not as dramatic or easily quantified as the savings from CRP adoption, the potential profit improvement of the shift to category management could easily exceed the cost savings from CRP. Category managers in retail chains were ideally responsible for the entire profit of a product category across all stores. Replacing buyers, who were primarily focused on cost or promotional deals, with category managers responsible for both profits and meeting consumer needs required new skills and capabilities. The shift from buyer to category manager represented a new mindset, for both the individuals in the role and the overall organization. Few buyers were able to make the transition to the new role, and few organizations could make the shift in procurement and merchandising strategy without a strong CEO vision and mandate for change.

The shift to category management benefited both retailers and P&G Category managers were better positioned to understand the true costs and profits generated from each product in their category. P&G customer teams were able to use solid economic analysis with category managers to demonstrate that their brands should be given additional shelf space or variety because the retail profit per unit of shelf space for P&G brands was higher than most other products in the category. In addition, category managers were able to appreciate the storage and handling savings provided by P&G's simplified pricing policies and logistics programs.

Sale of the CRP System to IBM

In late 1993, P&G announced the sale of their CRP system to IBM's Integrated Systems Solutions Corporation (ISSC) subsidiary. The P&G CRP system was to be offered by IBM to all manufacturers as a service provided by IBM, with P&G outsourcing support and operations of their CRP systems to ISSC. Within two weeks, Ralston Purina signed up as IBM's first customer, and five other manufacturers had become IBM CRP clients by mid-1994. Many other large manufacturers had expressed interest in the IBM service offering, which offered manufacturers CRP systems capabilities quickly, at low cost, and with experienced operating personnel. This IBM CRP service offering allowed retailers to interact with multiple vendors in a common format, creating a powerful force in the industry for standardization. The availability of the IBM CRP service also increased the attractiveness of CRP for manufacturers and retailers by reducing barriers to CRP adoption.

The decision to sell the CRP system to IBM was primarily based on strategic, not economic, justification. The net benefits to P&G and its customers of implementing CRP increased as the total number of customers and other manufacturers using CRP increased. Therefore, it was more important

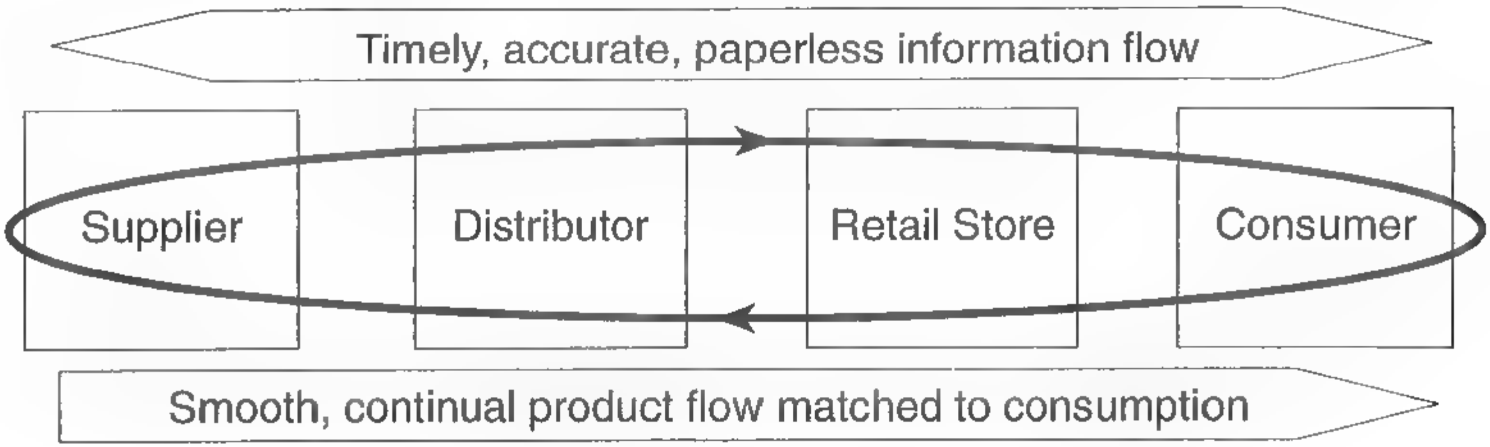
for P&G to be sure this innovation was rapidly adopted by the industry overall than to try to gain advantage from being the technological leader of the innovation. The sale to IBM increased the probability of other manufacturers adopting CRP by providing them access to a complete CRP service offering with quick start-up capability.

In addition, the agreement with IBM reduced P&G's cost of operating the CRP system, since the IBM service contract cost was less than the cost of operating the system using P&G's internal staff and systems. IBM planned to run the applications using excess capacity at the Kodak operations center that IBM was managing under an IT service contract. Thus, IBM was able to operate the outsourced CRP operations on capacity that would otherwise be underutilized from another outsourced MIS operations client. The outsourcing of CRP services to large manufacturers also gave IBM an opportunity to demonstrate the potential benefits of MIS services outsourcing to multiple potential clients, who might be interested in further outsourcing services that could be linked with the CRP applications over time. In summary, P&G's sale of CRP systems to IBM offered important strategic and operational benefits for both companies and provided the credibility of a third-party platform offering to increase the attractiveness of CRP for the industry.

Jager believed that any technologica. advantage P&G lost by selling the proprietary CRP system to IBM would be more than offset by the benefits for consumers and for the company of having the grocery industry fully embrace CRP. Increased adoption of CRP by P&G's customers would allow the company and its customers to improve internal processes and reduce costs. Jager explained:

> By eliminating nonvalue-added processes, we will ultimately win in the market by providing the best product to the consumer at the lowest cost through the channel.

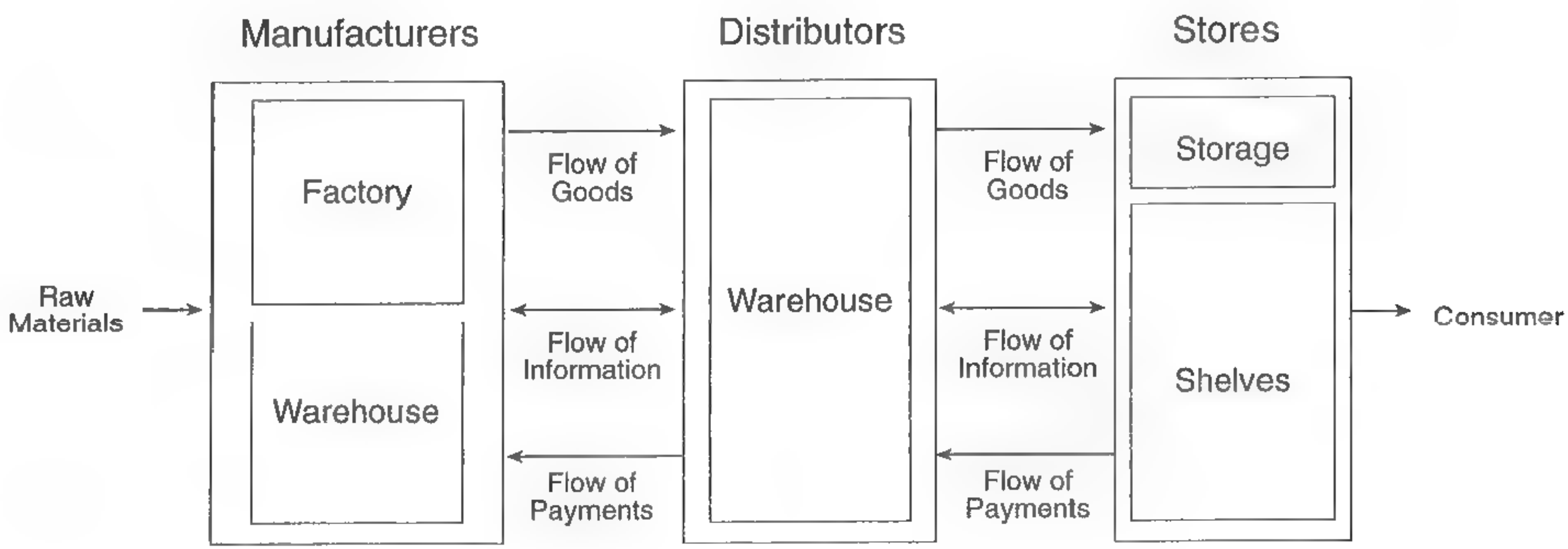
Exhibit 1: The ECR Vision – A Continuous Channel Process



ECR STRATEGIES	ECR OBJECTIVES
Efficient Store Assortments	Optimize productivity of retail space and inventory
Efficient Replenishment	Optimize time and cost in the ordering process
Efficient Promotions	Maximize total system efficiency of promotions
Efficient Product Introductions	Maximize effectiveness of new product development

Source: Company

Exhibit 2: Simplified Grocery Industry Functional Value-Chain

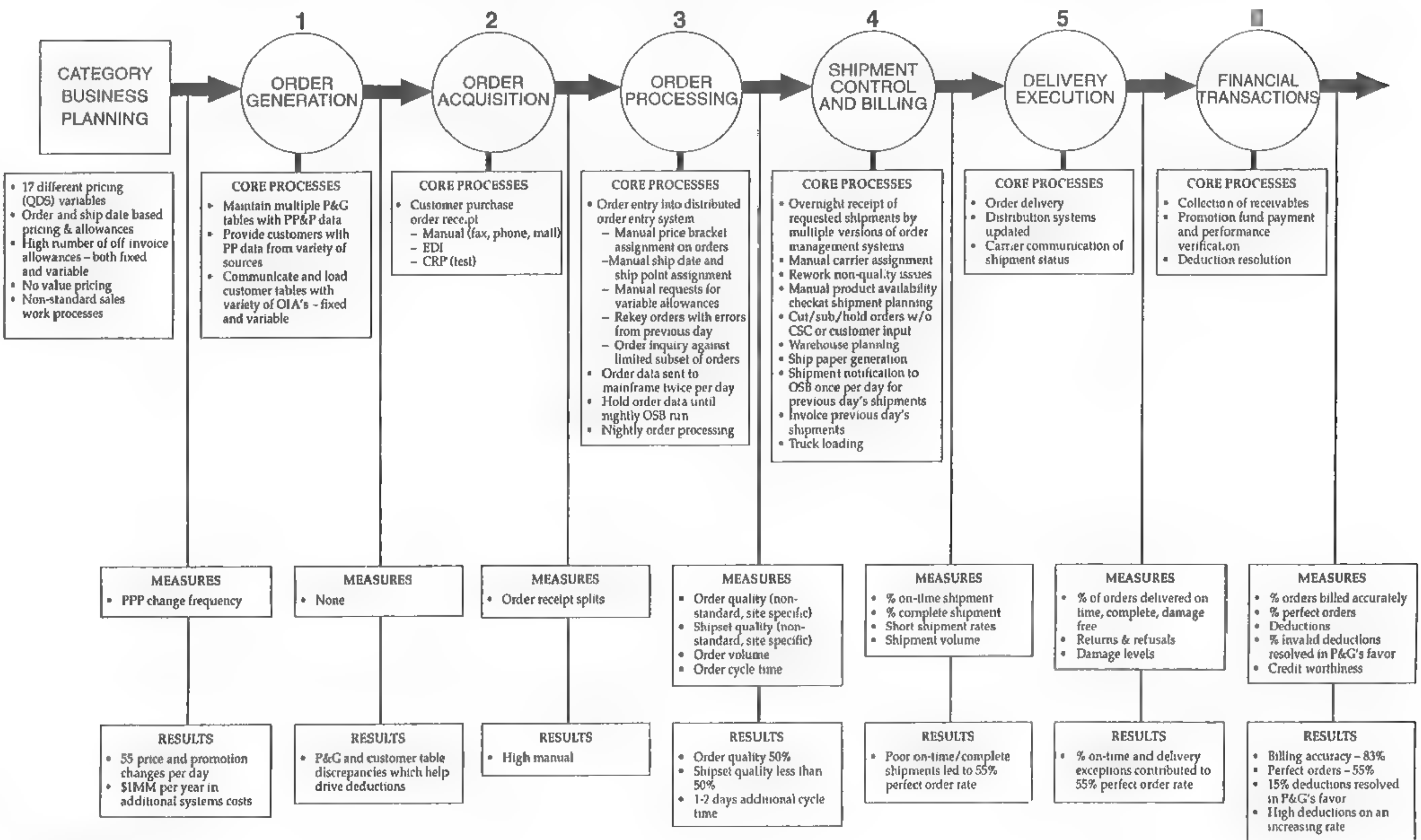


Flow of goods is frequent and high-volume and may be provided by trucks owned by one of the channel members or by a third party.

Flow of information was minimal for most channel members in the early 1990s, mostly conducted via voice telephone, paper mail, and face-to-face communications.

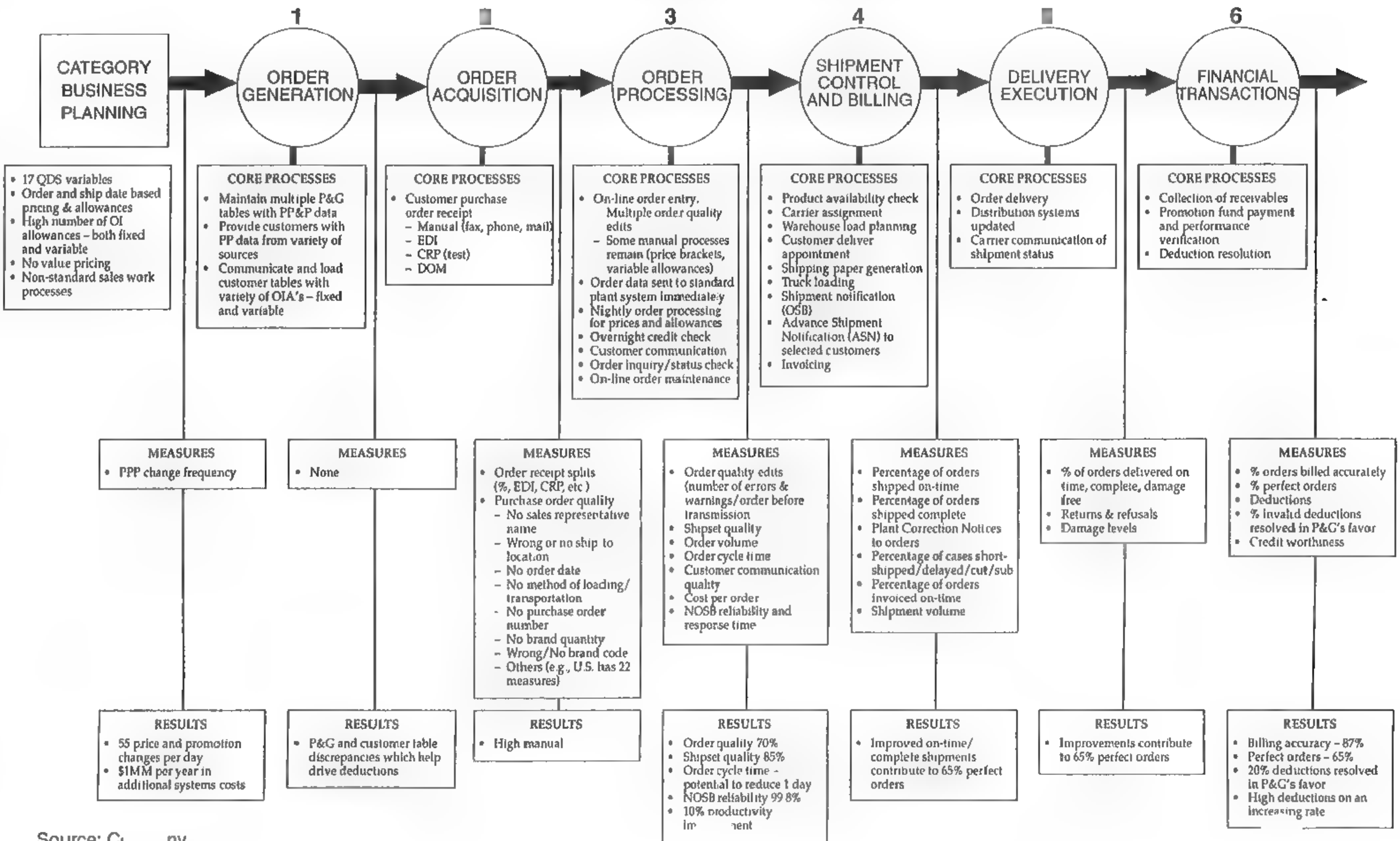
Source: Company

Exhibit 3: Total Order Management Process Before New OSB (1988)



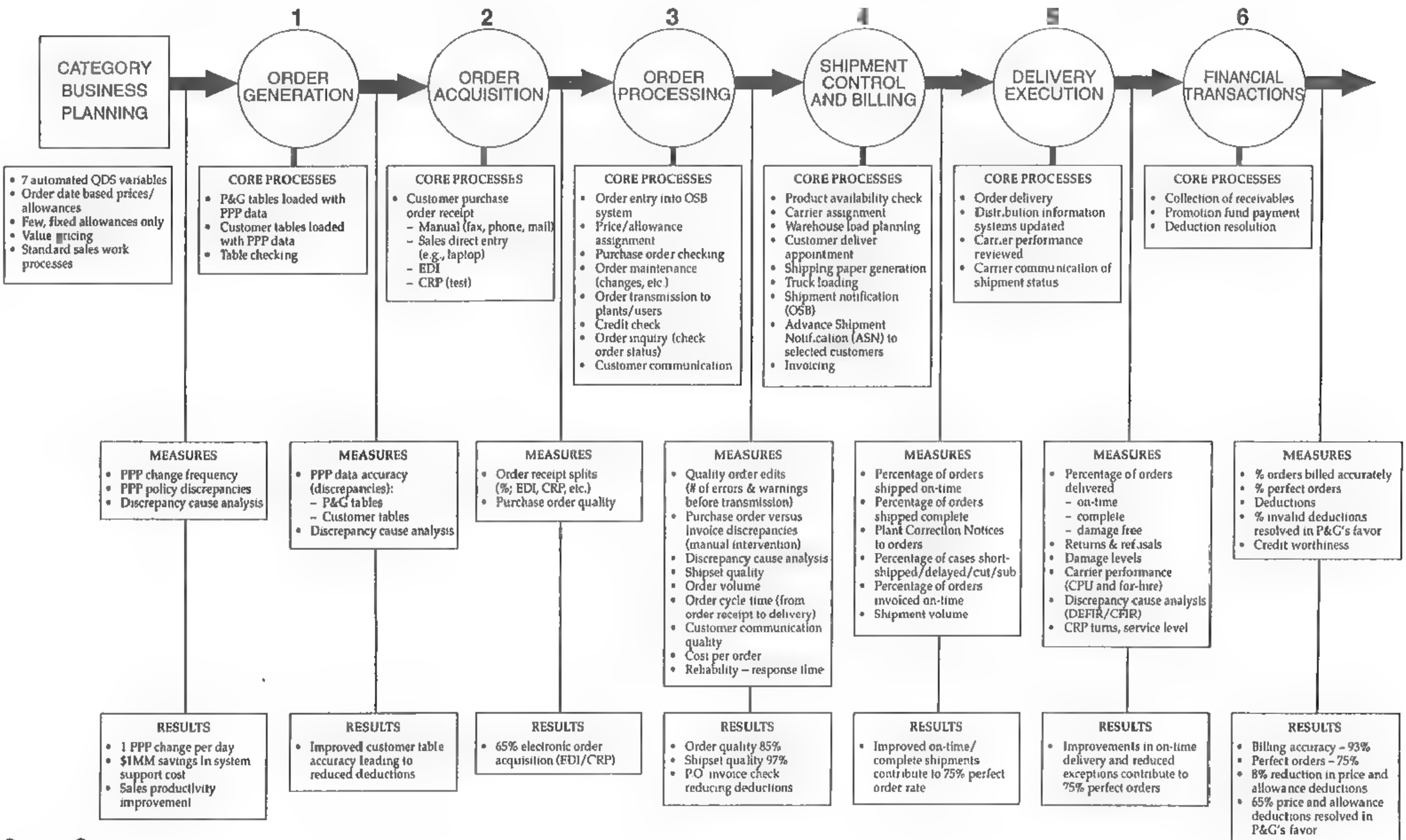
Source: Company

Exhibit 4: Total Order Management Process After New OSB (1992)



Source: C ny

Exhibit 5: Total Order Management Process After Redesign (1994)



Source: Company

Exhibit 6: Value Pricing Timing and Product Volume

VALUE PRICING INITIAL DATE	PRODUCT BRANDS OR CATEGORIES	% OF TOTAL P&G SHIPMENT VOLUME
July 1991	All liquid dishwashing products, some bar soap products, some Duncan Hines products	8.2%
August 1991	Metamucil	0.6%
November 1991	Bold, Liquid Bold, Solo, Cascade, Liquid Cascade, all Bounce products, Downy Sheets, all Comet products, Mr. Clean, all Spic and Span products, Top Job, Lestoil, Gain, Ivory Snow, Dash, Dreft, Oxydol	11.3%
February 1992	Pantene, Liquid Safeguard	1.0%
April 1992	Luvs, Pampers	7.0%
July 1992	Old Spice Deodorant, Downy Ultra and Regular, Secret, Sure, Bounty	12.8%
October 1992	Always, Attends (retail)	2.0%
November 1992	Liquid Cheer, Liquid Tide	4.3%
January 1993	Prell, Cinch	0.5%
March 1993	Tide Powder, Cheer Powder, Era	10.2%
May 1993	Puffs	1.0%
July 1993	Head & Shoulders, Charmin/White Cloud, Scope	8.9%
August 1993	Hawaiian Punch	1.3%
Total product volume with no off-invoice allowances in August 1993		69.1%

Source: Company

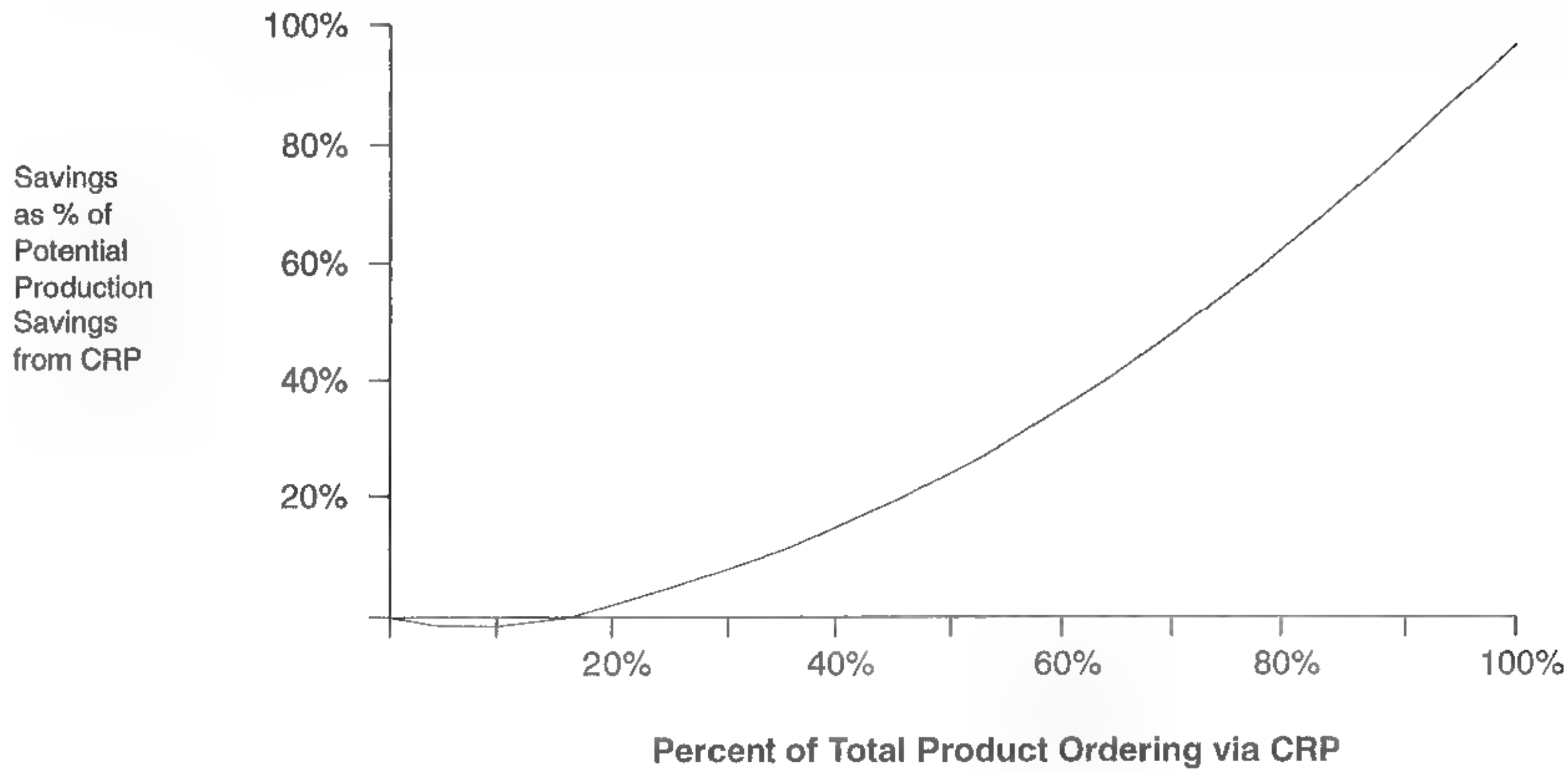
Exhibit 7: Selected P&G Financial Statistics

	1987	1988	1989	1990	1991	1992	1993
Net Sales	$17,000	$19,336	$21,398	$24,081	$27,026	$29,362	$30,433
Net Earning	$786	$1,020	$1,206	$1,602	$1,773	$1,872	$2,015
Net Earnings Per Share	$1.13	$1.49	$1.78	$2.25	$2.46	$2.62	$1.87
Net Earnings as % of Sales	4.6%	5.3%	5.6%	6.7%	6.6%	6.4%	6.6%
Dividends per Common Stock	$0.68	$0.69	$0.75	$0.88	$0.98	$1.03	$1.10

Note: These numbers exclude extraordinary charges of $459 in 1987 and $1746 in 1993 for costs of restructuring (plant closings and staff reductions), and a charge of $925 to reflect accounting changes in 1993.

Source: Company

Exhibit 8: Projected Manufacturing Cost Savings using CRP Ordering



Source: Estimates based on interviews with P&G manufacturing and product category executives

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INFORMATION TECHNOLOGY AT ROSENBLUTH TRAVEL: COMPETITIVE ADVANTAGE IN A RAPIDLY GROWING GLOBAL SERVICE COMPANY

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Information Technology at Rosenbluth Travel: Competitive Advantage in a Rapidly Growing Global Service Company

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ABSTRACT: Over the past ten years, Rosenbluth Travel has grown from a regional travel agency with $40 million in annual sales to one of the five largest travel agencies in the United States, with sales of $1.3 billion. Their strategy was based on exploiting the structural changes initiated by airline deregulation in 1978, including growth of the corporate travel market and increasing economies of scale leading to consolidation. Information technology (IT) was a fundamental part of this strategy. The case sheds light on several theories on gaining competitive advantage through IT; these theories feature technology leadership, leveraging critical resources, the role of IT infrastructure, and switching costs. While these theories contribute to an explanation of Rosenbluth's success, a critical factor appears to be the vision to see an opportunity and the ability to hustle to exploit it.

KEY WORDS AND PHRASES: business history, competitive advantage, information technology, strategic information systems, travel industry.

1. Introduction

ROSENBLUTH TRAVEL, HEADQUARTERED IN PHILADELPHIA, Pennsylvania, is not a typical family business. Yes, the president, a fourth-generation Rosenbluth family member and officer, still personally meets with every new associate (as employees are called), and there is a pervasive concern for associates that may be more characteristic of a progressive family than of a modern corporation. But Rosenbluth Travel (RT) has grown from gross annual sales of $40 million in 1980 to $1.3 billion in 1990.[1] RT has emerged as one of the five largest travel management companies in the United States [3], with over 400 offices nationwide. RT has projected their presence across

the globe through the Rosenbluth International Alliance, which was conceived and organized by RT. And in an era dominated by highly leveraged mergers and acquisitions, this dramatic growth was primarily internally funded through retained earnings.

This paper details the story of RT's rapid growth, trying to unravel the complex web of environmental and company-specific factors that have contributed to their current position. Of particular interest is the role information technology (IT) has played in the evolution of the industry and in RT's success.

Rosenbluth Travel exploited a fundamental discontinuity in their environment—the deregulation of the airline industry in 1978. Deregulation radically altered the travel products and services that customers demanded, as well as the cost structure for offering those products and services. The sheer complexity of route and fare structures dramatically increased the demand for services to help manage this complexity. RT successfully anticipated two key implications of this discontinuity:

- the increasing importance of IT for cost-effectively managing the complexity and leveraging valuable expertise; and
- the increasing importance of scale economies, in information and information systems as well as in other strategic resources.

Rosenbluth Travel understood that technology and market changes would interact to produce structural changes in the industry. They did not fully understand those changes at the outset, but were determined to be the first in the industry to understand and to exploit them.

The RT experience also offers insight into the construction of resource barriers that can protect a firm or strategic group against current and potential competitors. RT recognized the importance of IT to the industry early, and invested heavily in systems. While RT's early annual investment level would not have been prohibitive to competitors at the time, it has been used to build an infrastructure of systems and organizational learning that would be costly to match, prohibitively so for many competitors. This IT infrastructure provides a platform for continued innovation, lowering the cost and the development time for new services. Moreover, IT has been used aggressively to leverage and to extend the scale economies available in the industry, building volume, or size, into an important resource barrier for competitors.

But overall, the RT story is one of vision and hustle. At the time, the dramatic changes in the industry could have been exploited by anyone. In 1980 Rosenbluth had no significant financial clout or other resource advantage that many other travel agencies did not also possess. Moreover, RT's early moves could easily have been duplicated. RT's ultimate success appears to have depended on the vision of Hal Rosenbluth and his ability to create an organizational culture predicated on service and innovation.

Do we claim that RT has a "competitive advantage"? This is a notoriously difficult issue to address. RT appears to have established a solid position in the industry. In the Philadelphia market, RT controls 48 percent of business air traffic written out of the area. Moreover, they have been successful in winning large clients on major competitors' home turf, such as a recent contract with Compaq Computer in Houston,

the home base of Lifeco, one of RT's key competitors. Other major national competitors may emerge through mergers and acquisitions, but RT's size and technology infrastructure may give them an advantage in further consolidation. Of course, competitive advantage depends on profitability, not sales. Most firms in the industry are privately held or part of larger entities, so costs and profitability information is largely unavailable. Rosenbluth claims higher margins due to lower costs and more sophisticated pricing arrangements, but the effects of capital structure on this—particularly RT's investment in IT—cannot be determined. A good indication of RT's profitability is the fact that their phenomenal expansion has been funded internally from earnings, rather than through major debt or equity infusions.

But in the final analysis, the issue of competitive advantage is not the most interesting aspect of this case. We are more concerned with understanding the underlying forces, particularly the strategic use of IT, that have contributed to the players' current positions and that are likely to influence their future.

2. Travel Agents and the Travel Industry

TRAVEL AGENTS (TAS) EXIST PRIMARILY AS INTERMEDIARIES between suppliers of travel services, such as airlines and hotels, and customers. Unlike distributors in many industries, TAs do not deal with physical products, but with information. This information ranges from the objective and specific, such as the flights from New York to Boston tomorrow at 6:00 A.M., to the subjective and general, such as the pros and cons of Barbados as a vacation destination. The profitability and survival of TAs depend ultimately on the value of this information to customers.

Changes in the industry over the past ten years have dramatically altered the nature and value of information in the travel industry and, consequently, the role of TAs. At the heart of these changes are the economic forces unleashed by the 1978 airline deregulation and the role of IT in adapting to these forces. In the following sections we investigate in more detail these forces that have shaped competition in the industry and the resulting structure that has emerged.

2.1. Before Deregulation

Prior to 1978, the airline industry was regulated by the Civil Aeronautics Board (CAB). The CAB established fares and assigned routes to the carriers. Changes in routes or fares required CAB approval and were relatively infrequent.

Most of the major airlines had their own distribution networks but were in the process of shifting part of this role to independent travel agents. In 1976, it was estimated that only 40 percent of passenger tickets booked were placed through TAs [10]. A key tool in this process was the computerized reservation systems that were increasingly being made available by the airlines to travel agents and major corporate clients; at that time, these systems were just beginning to emerge as important marketing weapons.

In this environment, the travel agent's role was primarily to distribute tickets and to

provide advice on vacation destinations. Agencies with a computer reservation system (CRS) were little more than representatives of the CRS provider. Business travel was still significant, but there was no way for agencies to differentiate service. As a result, the industry was oriented primarily toward the individual traveler, with no distinction made between business or leisure travel. Even the largest agencies derived 90 to 100 percent of their revenues from such undifferentiated individual services.

Travel agents received their revenues primarily from a 10 percent commission on air tickets booked. With low entry costs, the industry remained fragmented and only marginally profitable. In 1979, there were over 11,000 travel agencies, only 25 of which had air sales[2] over $20 million.[3] Net profit margins were typically 1 to 2 percent.

2.2. Impacts of Deregulation

Deregulation led to fundamental changes in the travel industry. Travel agents emerged as key players in managing the increased complexity of purchasing travel services. Business travel costs soared, making corporate travel management an important market segment for TAs. Economic pressures stemming from airline deregulation and the expanding role of IT in the industry led to consolidation of both airlines and travel agencies, which continues to this day.

Following deregulation, airlines could add or delete routes almost at will. The number of available fares and fare changes exploded as competition intensified and as airlines became more sophisticated in pricing and yield management. This explosion of routes and fares created a level of complexity that simply was overwhelming for customers. SABRE, one of the two largest CRSs, contains 45 million fares and processes up to 40 million changes every month [10]. There was a tremendous need for some mechanism to manage this complexity. The airline CRS systems emerged to fill this need by providing rapid, single-source access to most routes and fares. But the complexity of the route and fare structures, and the complexity of the CRSs themselves, created the need for another level of specialist in the distribution chain: travel agents. Moreover, since the reservation systems were at the time extremely biased in favor of the owning carrier, TAs developed as customer-driven brokers, trying to overcome the bias in order to serve the customer. Of course, some agencies were more successful at this than others.[4]

By 1985, over 80 percent of air tickets were being distributed through travel agents [9, 10]. Deregulation had worked to increase the value-added of TAs, but there were still only limited economies of scale available, restricting profitability and consolidation. However, another impact of deregulation, the emergence of the corporate travel market, was occurring at the same time, furthering change in the TA market.

Business travel is the third highest business expense after payroll and data processing for the average U.S. business [1]. Prior to deregulation, this expense was viewed as an unavoidable cost of business. However, the explosion of routes and fares that followed deregulation created the possibility, and even the imperative, for managing these expenses. Expense management was particularly acute for businesses for several reasons. Airlines quickly realized that the average business traveler had little flexibil-

ity on the timing of a trip, and hence was less cost-sensitive than leisure travelers. This gave rise to fare structures that exploited this, increasing business travel costs. Moreover, the decision maker on business travel was most frequently the traveler, but payment was by the corporation, increasing the traveler's price insensitivity and contributing to the success of traveler-driven marketing efforts such as frequent flyer programs. As a result, business travel costs exploded following deregulation. As noted by Hal Rosenbluth, air travel may be the one industry in which the best and biggest corporate customers pay the highest prices when compared to what the leisure traveler pays.

Travel agents were dramatically affected by these changes in business travel. TAs had long been active in corporate accounts, sometimes opening offices on corporate premises ("satellite" and in-plant agreements). The 1982 Runzheimer study found that all but 7 percent of businesses surveyed utilized either an outside agency or an in-plant agreement with the vast majority (67 percent) using only outside agencies [13]. As deregulation put pressure on businesses to reduce costs, TAs found it necessary to increase the level of "rebating" or commission-sharing arrangements in order to compete in the corporate market. TAs had to look for ways to protect profitability, including new services and products as well as reorganization of operations to exploit scale economies. As the information link between suppliers and corporate clients, TAs were in a good position to accumulate travel information for planning and managing travel. In addition, they were well situated to develop a level of expertise in travel expense management, which most corporations could not cost-effectively develop or maintain on their own.

Perhaps the most important aspect of travel management to emerge in the 1980s was the use of negotiated rates and fares. As early as 1982, about one-half of firms surveyed with in-house travel departments were directly negotiating rates with hotels and car rental agencies [13]. These special prices were primarily corporatewide discounts and special group prices for specific meetings and events. In the mid-1980s a new frontier in price negotiation opened. By having access to detailed data on their corporate travel down to the city-pair level, firms were able to identify their high-volume routes and negotiate with suppliers for preferential fares on a route-by-route basis. Rosenbluth pioneered route-by-route negotiated fares and continues to be one of the leaders in this area today.

Maximizing the opportunities for negotiated prices required consolidating travel information over an entire organization to leverage purchasing power fully. This was particularly true for route-by-route negotiations, where the information demands are especially difficult. The organization had to be able to demonstrate to the air supplier that the increase in the volume from a fare program would more than offset the lower fares. This consolidation of information was greatly facilitated by utilizing a single agency. Moreover, the purchasing power of the TA itself could be an important factor in negotiations, creating another benefit for consolidating travel through fewer agencies. Negotiated prices are based on the ability of organizations to move market share. This requires being able to substantiate the effects of the program. TAs were in a good position to monitor compliance after the fact, but they were also more effectively positioned to encourage corporate travelers' compliance at the time reservations are made.

Finally, deregulation has indirectly contributed to consolidation in the travel agent industry. More directly, deregulation led to the importance of IT in managing complexity in the newly competitive industry and the increasing importance of purchasing power in negotiating fares and rates. Both of these factors increase the potential economies of scale, leading to consolidation.

Deregulation dramatically increased the importance of IT in the travel industry. IT was perhaps the only mechanism for cost-effectively managing the complexity that emerged in the industry following deregulation. Without IT, the sophisticated analysis of travel patterns necessary for negotiated fares would probably not be possible. With margins under pressure from rebating, increasing volume and thus increasing utilization of fixed resources was perhaps the best way to support profitability. IT investment is characterized by substantial fixed cost (e.g., development and hardware) with much lower marginal costs, leading to strong scale economies. Just as importantly, IT can be used to exploit latent scale economies in other resources, particularly expertise.

The increasing importance of purchasing power—that is, volume—has also contributed to the economies of scale, leading to further consolidation of travel agents. The process of route-by-route fare negotiations is strongly dependent on the ability to move volume, favoring larger agencies. In addition, larger agencies are in a position to contract for blocks of hotel rooms and other travel services at dramatically lower rates. While such *risk inventories* of contracted travel services provide these agencies with lower rates and higher availability, the agency must be able to manage this inventory effectively, or risk paying for empty hotel rooms or airline seats.

Hard evidence on the extent of scale in leveraging purchasing power is difficult to obtain. There is some evidence that size is an important determinant of an agency's ability to offer special fares: in the first quarter of 1989, 20 percent of total segments booked by mega-agencies were nonstandard, while this figure was 5 percent for large agencies, 2 percent for medium agencies, and less than 1 percent for small agencies [3]. These figures do not distinguish among corporate discounts, special group rates for single meetings and events, and fares negotiated by route.[5]

Ultimately, the increasing scale economies created by the greater importance of IT and of purchasing power are self-reinforcing. Purchasing power cannot be exploited without information technology to identify opportunities for negotiation and to monitor the economic effects of the program. At the same time, information technology cannot be fully exploited without size, since volume is required to drive the average cost of IT down and provide bargaining power for price negotiations.

2.3. The Industry Today

2.3.1. Players

Despite the tremendous consolidation among travel agencies over the past ten years, the industry still must be considered relatively fragmented. In air sales, no player has

more than a 3 percent share. But there are several definite groupings within the industry.

The industry consists primarily of very small "Mom and Pop" travel agents. In 1989, 19,000 of the 20,000 travel agencies in the United States were under $1.5 million in air sales, out of total air sales of $45 billion.[6] This competitive fringe may dominate in terms of numbers, but accounts for less than half of the industry air sales and is a negligible presence in the corporate market.

After the competitive fringe, there is a range of large regional and national agencies. These agencies follow a wide variety of strategies and are generally active in the corporate market. There are only a handful of truly national players in this group, including Rosenbluth, Lifeco, and Thomas Cook/Heritage/Crimson, all of which are in the $1 billion total revenue range and have air sales over $500 million [3]. But many smaller agencies can compete for national accounts through the various consortia, affiliate networks, and franchises that have emerged (see below). At the top end of the industry, there are American Express and the Carlson Group. The agency revenues for these diversified travel giants are difficult to gauge, but their total travel agency revenues have been estimated at over $2 billion [3].

As noted earlier, there are considerable economies of scale emerging in the industry, primarily in corporate travel management. These economies of scale are driven by information technology as well as by the ability to leverage purchasing power through negotiated rates and risk inventory. It is interesting to address whether the technology and purchasing power benefits can be obtained other than by ownership. There are several large consortia, franchise, or affiliate networks that have emerged in the industry. Examples include U.S. Travel Services, Woodside Travel Management, and Hickory Travel Systems. These networks provide systems and negotiating services for members, usually for a membership fee. It is not apparent whether networks offer a reasonable alternative to owned companies. The past few years have seen a decline in consortia in favor of wholly owned systems and franchises [3].

It appears that name identification, service, and control requirements limit the network concept. One company we spoke to that had changed from the Woodside network to Rosenbluth in 1987 noted that Woodside had had considerable difficulty in producing useful consolidated reports. This problem was so severe that the company was not in a position to begin negotiating fares until it moved its account to Rosenbluth.

2.3.2. Suppliers

Continued concentration has been the rule in virtually all industry segments supplying the travel industry. From airlines to hotels to rental car companies, consolidation has been rampant and is continuing, particularly into the global arena. One important result of this consolidation has been an increase in the use of negotiated fares for large corporate and travel agency customers.

Perhaps the suppliers having the most impact on the travel agent business are the airline computerized reservations systems. Over 93 percent of travel agencies in the United States use a CRS [4]. This industry is clearly dominated by American Airline's

SABRE system and Covia's Apollo, which together account for 68 percent of all segments booked (1989) [3], and this dominance is expanding globally. The CRSs are critical in performing the TA function. Just as importantly, the CRS provides the primary telecommunications and information systems infrastructure for the travel agents.

Computerized reservation systems have traditionally had considerable power over travel agencies, although this dominance has recently been waning. Regulatory efforts have limited the range for CRS action, covering how flights are displayed on the CRS screens, access to the system, pricing, and other important areas. Additional regulations are expected [4]. A few agencies are of a size where they can counteract some of the CRS's power. While the majority of TAs are tied to a single CRS with restrictive lease agreements, megas such as Rosenbluth possess all major CRSs, a benefit secured by their tremendous purchasing power. Moreover, the CRSs are slowly being forced to open their systems by the avalanche of new technology available on the market. From travel agent back office software to corporate travel management software, new capabilities and customer demands are gradually forcing the CRS to be more accommodating to third-party systems as well as to improve the capabilities and tools offered through the CRS.

2.3.3. Customers

The travel market is frequently broken down into three segments: corporate travel, leisure travel, and meetings and incentive travel. Our focus is primarily on the corporate travel market, but we will discuss the other two briefly.

The leisure market is usually for individuals and is characterized by much more cost consciousness and the flexibility to adjust timing to save money. Most of this market is straight commission work for the TA. Knowledge of destinations is highly valued, but to date has not been managed in any cohesive fashion. Recently, tremendous opportunities have opened up for vacation packaging. Large packagers can use their purchasing power to negotiate very attractive rates. Margins in this business can be much higher than in individual or corporate travel.

The meeting and incentive market serves organizations arranging meetings, conventions, and other group events. This market has numerous similarities with the corporate market, but is characterized by a higher need for coordination of various people and elements (hotel, transportation, food, etc.). Purchasing power is very important in negotiating these events, and margins can be higher than individual or corporate business, as is the case with group leisure travel.

Corporate travel is an extremely important part of the TA market. It is estimated that firms spent over $115 billion on corporate travel in 1990 [1], a good portion of which flows through travel agents. Over 90 percent of corporations surveyed by American Express in 1988 made all of their travel arrangements through TAs [1].

Despite the importance of travel and entertainment (T&E) expenses to corporations, T&E management has historically not had the attention of top management. The 1986–87 American Express Survey of Business Travel Management [1] found that

only 44 percent of respondents had a "strong, consistent management approach toward T&E." Moreover, only 16 percent had a "travel manager/coordinator" position. The situation appears to be changing slowly. The 1988–89 American Express Study found that firms with a travel manager/coordinator position increased to 29 percent of those surveyed.

One result of the increasing management attention toward T&E has been a trend toward consolidating travel through fewer agencies: a recent survey found that 60 percent of the firms that use travel agencies have consolidated travel through a single agency [1]. There are significant benefits to such consolidation. Firms can better exploit their purchasing power with TAs, bargaining both for special services and for price. Using fewer agencies also makes it easier to accumulate and utilize firmwide travel information. This information is critical in leveraging firms' bargaining power with specific suppliers and is also important for monitoring and controlling travel expenses. Moreover, there are strong economies of scale for the travel agents in servicing consolidated accounts, which create benefits that are shared by the company.

With the increasing sophistication of clients and the utilization of fewer agencies, the process of selecting a national agency for a large corporation has become very expensive and time-consuming, for both the corporation and the bidding agencies. As a result, TA–client relationships are becoming more long-term and cooperative in nature.

3. Rosenbluth

THE DRAMATIC INDUSTRY CHANGES DESCRIBED IN THE PREVIOUS SECTION provide the backdrop for Rosenbluth Travel's growth into a national mega travel agency. But RT did more than just ride the wave of change. RT was consistently at the forefront of the industry in terms of services and technology. This section reviews the evolution of their business and strategy, focusing on the role of IT.

3.1. Evolution and Strategy

Rosenbluth Travel was founded as a steamship office in 1892. By 1979, the firm had grown into a significant regional travel agency, deriving the majority of its $40 million revenues from leisure travel. Deregulation and Hal Rosenbluth hit the company at around the same time.

It is not unusual to hear of an executive starting at the bottom and working his way up. Hal Rosenbluth did it a little differently. After a period of jumping around in various positions, he demoted himself from a vice president to a reservations clerk, where he worked for two years. It was a dramatic and important time for the industry. Deregulation was shattering its foundations, and some experts were predicting the demise of the travel agency as a factor in the industry. Hal Rosenbluth and his colleagues viewed the situation a little differently: "What did deregulation mean? We weren't sure we knew. But if all the bets were off, the company that could gather information faster and turn it into knowledge would win." This experience "in the

trenches" was critical in forming the vision that was to guide RT over the next decade: "If you are doing it every day you have a better idea of what is going on. I could sense the customer's frustration over the phone."

By 1981 Hal Rosenbluth was convinced of the importance of the corporate travel market and the critical role IT would play in servicing that market. He pulled all the corporate travel agents from all offices and set up the first centralized TA corporate reservation center in the country. The objective was to exploit economies of scale, but, just as important, to facilitate the gathering and utilization of information as a basis for improved service.

During this phase, RT began to experiment with postprocessing reports from the CRS backroom systems to offer more effective travel management reporting. At the time, the CRS allowed agencies to add private data fields to reservations data. This facility was used by TAs to append accounting data for corporate accounts. Through the CRS-provided backroom systems, the agency could generate a limited number of reports. However, there was no capability for modifying reports based on internal information. RT performed some of this reporting by downloading the data from the CRS and manipulating it locally to produce reports better customized to corporate clients.

In 1983 RT introduced READOUT, a product that turned the flight selection process around, listing flights by fare instead of by time of departure. The CRS would display available flights only by time of departure; in order to find out the cost of a flight, the agent would have to switch back and forth between a fare screen and the list of flights. In contrast, READOUT would display the flights for a particular city-pair in order of increasing fare, so the cost implications of a particular flight selection were immediately apparent at the point of sale.

This simple innovation was a tremendous source of value-added to RT and led directly to new corporate accounts. According to Hal Rosenbluth, "The public was confused. No one knew what airfares were available. That's when we realized we were in the information business, not just the travel business." The original program was manual and developed and operated at very low cost. Each morning, beginning at 6:00 A.M., all reservation systems were reviewed for fares along major city-pairs. Then by the start of the business day, these fares would be made available to the corporate reservations clerks, at first just posted in the front of the reservation center, but later available automatically through the CRS.[7] The initial forty city-pairs have since been increased to over 700, and the process of scanning the CRSs and compiling the fare lists is now fully automatic.

The period 1983–85 saw continued growth in corporate business. During this period, RT made the significant jump from regional to national player. Air sales doubled from $150 million in 1983 to $300 million in 1985. In 1984, Du Pont became RT's first national account, with a $100 million per year travel budget. This move put RT up against the Woodside Travel consortium, of which it was a member. RT had joined Woodside to exploit the purchasing power and national presence of the consortium. As RT grew, this membership seemed more and more restraining to Hal Rosenbluth. There was considerable variation in the quality of service among the membership,

which Hal Rosenbluth felt diluted RT's emphasis on "elegant" service. RT's technological sophistication was far ahead of the average Woodside member, increasing the feeling that RT was paying too much for too little. Most important, Woodside had assigned exclusive sales territories that sharply limited RT's potential for expansion. The Du Pont account required RT to establish offices that directly violated these assigned territories. Conflict with Woodside continued as RT's national business grew, until RT left the consortium in 1986, a move Hal Rosenbluth describes as critical in "controlling our own destiny."

The need to "control our own destiny" underlies much of RT's evolution, and by 1985 Hal Rosenbluth was becoming increasingly dissatisfied with another threat to RT's autonomy: the airline CRS. The CRS was essential in performing the TA's function, and the CRS providers had leveraged this critical position into control over virtually all aspects of the business. All hardware and software (including operating systems and protocols) were closed systems, with fixed functionality, and were sold as "black boxes." This included the "front-end" reservations functions, as well as the "back-end" processing for accounting and travel management reporting. The back-end processing was subsidized by the CRS, further tying the agency to the provider. Even though biasing of screen displays had been curtailed by regulation in 1984, this strong position of the CRS gave considerable clout to the host airline. Agents would receive higher commissions, or overrides, based on sales targets negotiated with the airlines. It is certainly not surprising that such deals were more common with the host airline of the CRS used.

For Hal Rosenbluth, the primary issue was control over back-end processing. RT had some flexibility in structuring the reports through postprocessing, but this was still limited. Overall, the CRSs were not sufficiently responsive to corporate clients' needs for reporting and control. In fact, by allowing the CRS to subsidize the back room, the agency was prevented from fully servicing clients' needs. As Hal Rosenbluth has said, "Knowledge is in the back office. If you are dependent on a CRS provider for your back office, you can't fully utilize the knowledge. How can you ask United Airlines' Apollo to help you shift a client's business to American, or vice versa?"

In 1985 and 1986, RT pushed to develop its own back-office technology base independent of the CRS. With little IS expertise, RT began with a third-party software package. As RT gained experience, this package was extended and customized to address RT's needs better, and was eventually replaced with proprietary software. A critical step in this process was the hiring of David Miller (now Vice President, Global Information Technology) as RT's first Director of MIS. This technology initiative was a major commitment for RT and unprecedented in the industry; Miller estimates that in 1986, RT invested close to one-half of pretax profit in systems.

The back-office system, called VISION, produced its first set of reports in 1986. The key benefits of the system were the accuracy and completeness of information and the power and flexibility of reporting. VISION trapped a record of all transactions made on behalf of clients at the time of ticketing, regardless of the RT location or the CRS used. The CRSs were still used for booking a reservation, but a record of the transaction always went to VISION also. Extensive quality control

features were built into the system. Profiles of information required for each client, such as accounting codes and employee numbers, were maintained in VISION. Transactions entered into VISION were checked for completeness and accuracy. Exceptions were cleared within a day.

The resulting VISION database provided complete and accurate information and enabled considerable flexibility in reporting and analysis. The first set of reports streamlined and combined statements to improve their usefulness. Soon, reports could be tailored to specific client needs. Data were retained for thirteen months to allow trend and YTD reporting. Special reports could be produced to identify opportunities for price negotiations and investigate the impact of travel policy changes on expenses. VISION also supported linking directly with clients' internal systems, such as expense reconciliation and accounting.

In contrast, TAs relying on CRS back-office systems would have to wait until tapes of transactions were received (up to forty-five days) and then would manually review them for completeness. Consolidation of client information involved manual merging of data from multiple CRSs and (possibly) multiple agencies. Since there was no front-end control of company-defined codes and formats, this process could be extremely difficult, leading to considerable "reconstruction" of data. Flexible reporting of consolidated information was virtually nonexistent. According to David Miller, "VISION was so different, it was a quantum leap for the marketplace. VISION was key in signing up millions in sales from new accounts."

The capability of VISION also enabled RT to pioneer negotiated route-by-route fares with airlines. While special corporate rates with car rental companies and hotels were common at the time, airlines only offered limited special fares, primarily for group travel. Hal Rosenbluth realized that there were considerable opportunities for exploiting purchasing power if it could be coordinated and directed. With the VISION database, high-volume routes could be identified. The information could be analyzed to convince suppliers that the revenue from additional volume due to a rate program would more than offset the lower fares, benefiting all parties. VISION also enabled the effects of a program to be monitored to ensure that the expected effects were realized.

Negotiated route-by-route programs and the reporting ability of VISION led to a significant change in the way RT approached the corporate travel market. At the time, corporate travel was sold almost exclusively by price, that is, agency commission sharing; travel agents would typically rebate to clients 15 percent of their commissions. At the height of the TA price wars in the late 1980s, rebates could go as high as 40 percent of commissions, or 4 percent of total air sales and room billings. RT took another tack. Instead of competing on price, RT adopted a more cooperative approach based on service and partnership. Instead of rebates, RT offered guaranteed savings through lower airfares. RT maintained that it could reduce overall travel costs for the client while still earning its standard 10 percent commission. This claim could be backed up by reports from the VISION system comparing prices paid to the lowest available fare.

The next phase in RT's back-room strategy was to push information down to the

hands of users. This has led to the PC-based USERVISION product, a flexible query system to access VISION data that is currently being rolled out. Information is available online with only a one-day lag, compared to the forty-five-day lag common in competitors' systems. The package has a variety of standard analyses and a capacity for flexible custom reporting. Information can be downloaded to other popular PC programs for further analysis.

In 1988, RT began another strategic move that, while based on technology, was much more far-reaching than just a technology play. In 1988, Apollo introduced the ability to access the CRS through intelligent workstations with local programming capability (called scripting). Combined with the ability to store proprietary information within the CRS, TAs could now build sophisticated proprietary applications that had access to the CRS data and network. RT used this opportunity to undertake a major reevaluation of the front-end sales process. According to David Miller, "We did not just automate the old way of doing business." The result was PRECISION, a radically new front-end support system. PRECISION made available to the reservation agent the relevant employee and client profiles as well as the READOUT database. The dialog was designed to reduce data entry and increase front-end validation. For example, the dialog identifies all information required by that particular client for subsequent reporting and, where possible, pulls that information up from the traveler or company profile. Fares are shown from the READOUT database, that is, from lowest to highest relevant fare, including any Rosenbluth or company-specific negotiated fares. While Rosenbluth guarantees that the lowest available fare will be used, if two fares are equal, the one with the highest margin for RT will be listed first.

PRECISION creates several advantages for consolidating travel through Rosenbluth. Corporate policy and traveler profiles are available through PRECISION to all Rosenbluth offices. One corporate client pointed out that this greatly facilitated the ability of the company to "move share" with special fare programs. A new or modified fare program would be immediately available to all travelers anywhere in the country. Very few companies actually charge the TA with enforcing policy, but by making policy and special prices available at the reservation point, PRECISION enhances compliance with travel policies. PRECISION also greatly improves the quality of the data by pushing validation closer to the point of sale.

The quality control aspects of VISION and PRECISION were significantly enhanced with the introduction of ULTRAVISION. Running parallel to the normal reservation process, this system monitors transactions for completeness and accuracy, using criteria from the VISION database. Errors are identified and routed for correction on a real-time basis.

The VISION, PRECISION, and ULTRAVISION initiatives fueled a tremendous burst of growth. Gross annual sales jumped from $400 million in 1987 to $1.3 billion for 1990. The number of offices has jumped from eighty-five locations in 1987 to over 400 today. This sales growth has overwhelmingly been from internally generated sales, as opposed to acquisition. RT only opens offices in locations where they have committed clients, never on speculation. While acquisitions have been made, the objective has always been to service RT clients rather than to acquire clients.

Currently, RT is coming under some increased competitive pressure. Consolidation in the industry is continuing. In 1989, the top five players accounted for 67 percent of the air sales of the largest twenty-five companies, compared to 55 percent in 1984 [3]. Globalization is introducing new competitive pressures. Moreover, competing megas are beginning to respond to RT's technology initiatives.

But RT is still resisting competition based solely on price, preferring to negotiate with services. Where RT has been forced to compete on price, other mechanisms are employed to protect their revenue stream. For example, RT may adjust the number and timing of management reports to fit a particular client's needs while protecting RT profitability. Moreover, RT can negotiate how savings created through RT negotiated airfares and risk inventory are shared with the customer.

Rosenbluth Travel's focus on value-added service has been a key element of their strategy from the beginning. Services range from programming a custom EDI interface with a client's internal systems to providing support for price negotiations. This approach often has beneficial side effects. For example, according to Gene Barraro, Transportation Planning, Administration, and Services Manager at Scott Paper Co. (Philadelphia, PA), RT developed a program at Scott for analytical support for car rental negotiations. This package is now being marketed to other clients. Also at Scott Paper, RT pays for a full-time travel consultant, whose presence Barraro credits with selling three Scott Paper divisions on Rosenbluth.

Closely related to RT's strategy of differentiation through value-added services is their dedication to the concept of partnership. This cooperative approach was very evident when we were talking with Gerald Ephraim, Manager of Travel and Fleet Services for Kodak. Kodak consolidated their national travel through RT in 1987. When asked to estimate what portion of Kodak's negotiated fares were due to Rosenbluth's efforts as opposed to Kodak's, Ephraim pointed out that they generally meet with suppliers together and that it is very difficult to "define who did what." The partnership approach extends to the CRS providers and travel suppliers. According to Ralph Smith, VP for Industry Relations at Rosenbluth, RT aggressively uses its purchasing power, but never in an exploitive way. The objective is to fashion an arrangement that is win-win-win—for the airline, the client, and RT. The information available through RT's systems supports this process by enabling goals and commitments to be quantified and monitored.

Rosenbluth's independence is also critical in their partnership approach. Independence from the CRS was one of the objectives behind the development of VISION, RT's back-office system. All of RT's systems are integrated with all of the major CRSs to further reduce reliance on any one supplier. RT views itself as a broker and feels most competitors are too wedded to their CRS and its host airline always to serve the client best. RT was the first in the industry to establish a lab that thoroughly tests all third-party hardware and systems (such as those from the CRS) prior to offering them to clients.

This desire for independence is also evident in RT's strategy for integrated T&E management. Several products are available that integrate pretravel information from the CRS, payment information from credit cards, and internal accounting information.

An example is Diners Club's TRACS system, which fully automates the filing and reconciliation of expense reports. Rather than committing to any one card or system, RT wants to work with all systems, a capability they call Fusion. Fusion currently provides links to Diners Club's TRACS, Covia s Travelmaster and SABRE's Capture products. RT is also investigating arrangements with VISA and Mastercard.

3.2. International Alliance

Rosenbluth Travel has extended their reach globally with the Rosenbluth International Alliance (RIA), which they organized in 1987. RIA currently includes thirty-four agencies in thirty-seven countries, having combined annual sales of over $5 billion. With the increasing globalization of business in general, an international presence has become increasingly important to the corporate travel management business. RT feels that their alliance concept gives them a significant advantage in this globalization process. Once again, IT is playing a central role in this strategy.

Global presence is important in providing service for global corporate clients for two reasons: local travel support and global travel management. International business travelers are demanding local service wherever in the world they happen to be. This service ranges from adjustments to travel plans to handling medical or legal emergencies. RIA members have dedicated facilities for providing this local support to any RIA client.

Global travel management is, at this time, conceptually attractive but not yet practiced. However, RT believes there are tremendous opportunities for global travel management, and that exploiting these opportunities will drive the travel management business in the future. The RIA hopes to be in a position to allow its members to capitalize on these opportunities. At the heart of global travel management is the ability to aggregate travel information worldwide. Firms will be able to pinpoint high-volume routes and adjust policies to control travel costs. Carl Nurick, Vice President of International Development for RT, foresees the day where facilitating the global flow of people becomes an important part of overall logistics management for international firms. More imprtant, global visibility of travel patterns can create opportunities for negotiating fares with suppliers. RT has pioneered such negotiated programs in the United States with tremendous success, and Nurick feels the global possibilities are even more dramatic.

In order to approach truly global travel management, an organization must be in a position to accumulate travel information from around the world. This requires coordinating the coding and formatting of travel records and arranging the physical accumulation of these records. A travel agency with a closely integrated global network is in an excellent position to support this information accumulation and consolidation. The RIA is developing procedures to achieve this level of integrated information management for any RIA client, anywhere in the world.

In addition to addressing the travel needs of global businesses, a global service network also yields additional advantages to a travel agency, such as new sources of business, increased purchasing power, and a larger business base to support capital

expenditures. Successful handling of a company's travel needs can lead to additional business for the global travel management organization, servicing the firm's overseas subsidiaries and affiliates. For example, Nurick tells of one RIA client in Europe who has formally directed all subsidiaries in the United States to use RT. According to Nurick, such global referrals, while not yet significant, are growing in the RIA. A global network can dramatically increase the bargaining power of the firm when dealing with suppliers. The RIA has established a system where individual RIA members can negotiate programs with local hotels using the entire volume of the alliance, yielding significantly better rates. Finally, servicing global business requires expensive capital outlays for technology infrastructure. These expenditures can be shared by all participants, lowering the cost to any one participant.

While many TAs believe developing a global network is critical for future survival and growth, there are several ways to accomplish this. RT feels that its alliance concept has several advantages over the approaches being utilized by competitors. Several competitors, such as American Express and the Carlson Group, are spearheading their global expansion through establishing new, wholly owned subsidiaries, or through acquisition. According to Nurick, this ownership strategy was not feasible or desirable for RT. Global business requires omnipresence, and trying to establish owned entities throughout the world would have been prohibitively expensive for RT. Nurick feels the capital requirements for such a strategy are proving burdensome even for giants like the Carlson Group. Moreover, the nature of the travel business varies tremendously from country to country. RT felt that attempting to manage that diversity within a single firm would have been close to impossible. As a result, the RIA is structured as an alliance of independent organizations bound by common interest. Each member has the freedom to adjust to local conditions as they see fit and the areas of cooperation within the alliance are determined by mutual business needs.

The alliance concept is also significantly different from other cooperative approaches tried in the industry, such as the consortium approach of Woodside and the Business Travel International. According to Nurick, previous cooperative approaches have not succeeded, because of either burdensome administrative structures or lack of adequate integration. The RIA has attempted to avoid these problems through an innovative organizational structure and an extensive technology infrastructure to ensure integration.

The RIA organizational structure is based on the principles of equality of members and mutual self-interest. Potential members were carefully screened to ensure cultural compatibility and sufficient resources to meet RT's service requirements. The alliance is based on entrepreneurial local nationals with a service orientation and management style that fit well with RT. All decisions of the alliance are determined directly by the membership, including the allocation of the costs of the alliance. All members of the alliance have one vote regardless of size, so that smaller members do not feel overwhelmed. There is very little permanent administrative structure. Special-purpose committees are formed for specific projects and objectives, but these are staffed and funded by the participants.

Just as important as the organizational aspects is the technological infrastructure put

in place to ensure coordinated service. The backbone of this infrastructure is currently the Apollo CRS offered by Covia.[8] All RIA members must use Apollo for RIA functions (although actual transactions may be executed through other CRSs). The Apollo front end has been extended by the alliance with a RIA member reference system, E-mail, and a proprietary international hotel system. The RIA has been working aggressively with Covia, Galileo, and Gemini to extend the capability of the infrastructure. The capability for all RIA members to access a customer's itinerary and profile information (for RIA clients) is being implemented now. The RIA is developing procedures and formats for consistent travel records to support global reporting, and is developing front-end interfaces similar to PRECISION to facilitate information control and access.

Rosenbluth Travel does appear to be in the forefront in terms of technological infrastructure linking their global alliance.[9] Even though much of the infrastructure is based on Apollo, making the same basic functionality available to competitors, no competitor has been as aggressive in exploiting the available capability. Moreover, many of the systems that augment the front room and back room are proprietary. The RIA is continuing to work closely with the CRS provider to shape the evolution of CRS functionality and is investing heavily in proprietary systems to exploit and build on that functionality.

The future evolution of global strategies is highly uncertain at this point. Most of the other megas are embarking on major acquisition programs supplemented with affiliate relationships, while RT has not yet made an acquisition. Relying on the alliance concept for global presence introduces the possibility that the control problems that have plagued domestic consortia may also emerge in the RIA. RT hopes that the careful selection of members and the organizational structure of the alliance will minimize such problems. Hal Rosenbluth views the alliance as extremely successful to-date and does not envision the need for major foreign expansion through acquisition. This does not mean RT entirely rules out overseas equity participation: RT participates in equity joint ventures in Japan and in Hungary. While these are viewed as unique situations, the ownership situation will continue to evolve. Nurick points out that there are discussions among RIA members (other than RT) about stock swaps and potential mergers. Europe in particular is likely to see considerable ownership consolidation in the light of the 1992 accords. Nurick feels ownership consolidation and exchange will increase the stability of the alliance, although it is too early to make any predictions.

Another risk to the alliance is the possibility of opportunistic behavior on the part of members. This may take the form of performance shirking or appropriation of the alliance's technology or know-how. Nurick feels both of these risks are low. While there are no formal mechanisms for monitoring service levels, the close relationship with clients provides constant feedback as to the quality of RIA service. In only one situation has there been a significant service problem. In this case, the service problems were immediately apparent and the member was asked to leave the alliance. There are also no formal controls over technology or know-how. In fact, the free flow of ideas is essential to the alliance. But most of this expertise and technology is of limited use

outside the alliance. According to Nurick, the biggest risk is that a member will use alliance participation to increase its market value and then sell out.

4. Competitive Position

ROSENBLUTH TRAVEL HAS MANAGED THE TRANSITION from a local player to one of the handful of "megas" that dominate the market. They have accomplished this through a strategy of service, leveraging IT while exploiting, and at points defining, the emergence and growth of the corporate travel management market. The majority of small TAs cannot begin to compete with the service levels and cost structure of RT. But at the same time, RT is dwarfed by the consolidated sales and financial resources of diversified travel giants like American Express and the Carlson Group. Comparisons with similar megas, such as Lifeco and Cook/Heritage/Crimson, can be very difficult.

One way of looking at relative positions is in terms of *strategic resources* [e.g., 14]. Firms with an advantage in some key resources that are not easily duplicable or substitutable will generally be in a position to earn higher returns. There appear to be four critical resources in this industry: *information*, *expertise*, *information technology*, and *scale of operations*. In addition, there are important organizational factors, such as culture and management style, that significantly influence the effectiveness of these other resources.

One of the primary roles of travel agents is to be a conduit and accumulation point for *information*. This enables them to buffer customers from the complexity of the marketplace, reducing travelers' search costs and improving the match between customers and providers. TAs also accumulate information on travel patterns to aid corporate clients in developing effective travel policies and programs. Closely related to information is the ability to convert the information into effective action. This involves analyzing traffic patterns, designing travel policies, and negotiating supplier programs, all of which require specialized *expertise*. And, of course, *information technology* is the mechanism for accumulating information and converting it through expertise into effective action.

Scale of operations is perhaps the most critical resource, since it influences the potential economies of scale from information, expertise, and information technology. All three of these other resources are characterized by high fixed costs and low marginal costs, leading to significant economies of scale. Moreover, the purchasing power inherent in scale of operations is important in negotiating with suppliers and with customers.

In the following sections, we investigate each of these key resources. The key questions that need to be addressed are:

- Does RT have a comparative advantage in the resource?
- To what extent is the resource nonduplicable and nonsubstitutable?

4.1. Information

Travel agents serve to filter the vast quantity of information on supplier offerings in order to service customers' travel needs better. However, much of the information on

suppliers is actually accumulated and controlled by the computerized reservations systems, and is, therefore, not a strategic resource of the TA. However, there are some areas where TAs can build an information endowment that is definitely strategic.

- Other supplier information—Not all information is available through the supplier reservations systems. Traditionally, TAs have capitalized on this fact and have supplemented these data with information on quality, ambience, and other less concrete factors gleaned from personal experience and feedback from their clients.
- Travel policies and preferences—TAs can be an accumulation point for travel policies and preferences, and can utilize this information to match offerings to clients' needs better.
- Client travel history—TAs can be an accumulation point for travel history that can be used for internal management reporting, for developing and monitoring travel policies, and for negotiating special fare and rate programs.

In all of these cases, TAs serve as an accumulation point, rather than as the original source of the information. Since TAs are primarily information intermediaries, the strategic value of TAs' information base depends on their ability to accumulate and process the information at less cost than other intermediaries or the principal parties (suppliers and clients).

Rosenbluth Travel has sought to enlarge and leverage their information endowment in several ways. The IT infrastructure of VISION and PRECISION has been used to systematize and automate the accumulation, storage, and retrieval of information. The range of information handled by IT is continually being extended. For example, RT's hotel system can now report on travel distances among major hotels, airports, and meeting sites.

At this point it appears that RT has a comparative advantage in information over other TAs in the industry. No TA competitor has the IT and organizational infrastructure. However, there are some potential threats to this advantage. As more information becomes systematized and automated through IT, it becomes easier to transfer this information. New specialized information providers may emerge. Perhaps more importantly, the CRS may be in a position to expand its information base and functionality to cut into the value of RT's information endowment.

4.2. Expertise

A TA also provides value by being able to utilize the information from suppliers and customers to produce effective decisions and actions. This know-how, or expertise, can be an important strategic resource. RT has aggressively acted to build and exploit their expertise base. This can most easily be seen in their development of negotiated fares. Their ability to identify and to implement such programs has been continually enhanced. The experience has led to the development of new techniques and the identification of new opportunities. RT pioneered this area of service and remains a leader today.

Duplication of RT's expertise advantage is difficult. First, it is difficult for other parties to observe the processes involved. They may see the outcomes, but must infer the underlying activities leading to them. Second, the knowledge is embedded in a specific organizational context. The specific "how to" of rate negotiations would have less value without RT's information systems, relationships, and market share.

Still, the value of an expertise advantage will tend to dissipate over time, as competitors work out similar systems and practices. Continued innovation is critical in maintaining and exploiting a knowledge base, and RT appears to be well situated to continue to build and leverage their expertise base.

4.3. Information Technology

As noted earlier, RT's strategy has emphasized IT, leading them to be an aggressive innovator in the use of this technology. A key aspect of their IT strategy has been the creation and leverage of technical infrastructure: new applications are integrated with and build on the existing platform. The result is an IT resource base that is arguably the most advanced in the industry. They are investing heavily in maintaining this advantage.

Rosenbluth Travel's infrastructure allows clients to define their own information needs for management and then assures that information is complete and accurate. It supports flexible access to this information through relational database technology in a form appropriate for decision making. At the same time, it reduces costs by automating quality control and pushing problem resolution down to the point of sale. The impacts of the infrastructure extend to travelers. All information relevant to the transaction is available at the point of sale. The process of making travel arrangements is streamlined, improving service to the customer and also reducing the costs of handling the account.

Rosenbluth Travel's technology base also provides a platform for further innovation. Applications cascade, with each being based on previous applications. For example, USERVISION, which allows online access to travel data by the client, would not be possible without the VISION infrastructure. But perhaps the most important innovations made possible by the technology are in using the data; the sophistication and usefulness of analytical routines are subject to strong learning effects. Much of what RT does today in negotiating prices could not even have been considered without the technology base.

Although RT's initial annual investment in IT was easily within reach of most of their larger competitors, there has been considerable lag in competitors' response. Only within the past two years have competitors been seriously responding to RT's technology, and even then, the responses have typically been in a piece-by-piece fashion rather than based on a coordinated strategy. For example, all large players now offer their corporate accounts some form of online access to their travel data, as RT's USERVISION product does. However, no other firm has its own back-office systems such as VISION, so data must be collected from the CRS, usually by tape. Where USERVISION has a lag of one day in access to information, competing systems could average forty-five days. Moreover, with extensive automated quality control, RT

believes they have higher quality at lower costs than competitors' manual quality control procedures.

While RT seems to have enjoyed a technology resource advantage over other megas, and to have been able to leverage this advantage successfully in the marketplace, the other megas cannot be dismissed as threats. They certainly have the financial resources, and the additional advantages of learning from RT's experience. The CRS providers have recently been aggressively improving the tools and services available through the CRS, making it easier for competitor agencies to match RT's proprietary systems. Competitors' failure to respond rapidly may have had more to do with the fact that alternative strategies, such as the price competition pursued by most TAs, were at the time as viable as the differentiation strategy followed by RT. As technology increases in importance to the market, it is unlikely competitors will remain so complacent. This is evidenced by the increase in technology activity among the megas over the past year. Moreover, third-party packages are beginning to become available, making the technology available to many smaller travel agents.

Perhaps the biggest threat to RT's technology comes from the CRSs. A significant portion of RT's technology is actually an add-on to the CRSs to perform functions the CRSs were not able or willing to provide. As the CRSs become more independent of specific airlines, through the diffusion of ownership[10] and the introduction of non-industry owners, such as EDS, it is more likely they will expand to provide these services. All CRSs provide some system capabilities for corporate travel management. Moreover, the quality of tools available from the CRSs is being greatly enhanced. Competition among CRSs seems to be evolving in terms of the quality of these tools [10]. Involvement by the CRSs is even more threatening in that it could eliminate some of the TAs' information advantage, since the fundamental information source for all TAs is the CRS.

Rosenbluth Travel recognizes that CRSs may have an advantage in providing some of the services that are now proprietary to RT, particularly in the front room. The CRS could offer these services directly to corporations or to other TAs. However, there are significant limitations to the CRSs' ability to threaten RT and its technology base in the near term. Computerized reservation systems are historically and culturally tied to their host airlines. The risk of being tied to a single CRS provider is compounded by these links to the airlines, since it may be very difficult for them to establish the independence necessary to be an impartial provider of TA services. Moreover, the CRSs currently lack the deep understanding of the corporate travel market that TAs have. Of course, the CRSs are becoming less tied to their hosts over time, and they are beginning to develop internal expertise in corporate travel management, a process that could be accelerated through aggressive hiring or through acquisition of one or more major agencies, but there are substantial uncertainties surrounding the organizational and strategic changes required for the CRSs to be major competitors to TAs.

4.4. Scale of Operations

Size is becoming increasingly important in the travel industry. Larger firms are in a better position to negotiate with suppliers. More important, the key resources of

information, expertise, and information technology are subject to economies of scale. Rosenbluth's growth strategy can be best described as "bootstrapping." Expansion was sought through new business based on value-added services. IT was critical for providing these services while driving down costs. The scale effects of technology and size detailed above led to decreasing average costs as business expanded. At the same time, a premium could be charged for the superior services. The profits generated in this fashion were then reinvested in IT to fuel further growth. This strategy required RT to be an aggressive innovator. In fact, most of the services that define the corporate market today were pioneered by RT, from negotiating prices with the airlines to lowest fare guarantees for corporate accounts. The success of the strategy is clearly evidenced by RT's catapulting into one of the five largest agencies in the United States. RT's size advantage clearly is now a barrier to the majority of smaller agencies. Without the purchasing power, financial resources, service network, and technology base, the smaller agencies are at a significant disadvantage in the corporate travel management market.

Rosenbluth Travel's size advantage is not unassailable. The travel revenues of American Express and the Carlson Group are each about twice those of RT; the overall resources of these giants are considerably greater. Moreover, there are several other megas that have achieved size similar to RT, while following very different strategies. The other extreme from RT is USTS, founded in 1986. This company has grown almost entirely by acquisition. Most of the other "megas" have pursued some balance between acquisition and growth. For example, Lifeco has made several significant purchases, but a good portion of its growth has been internally generated.

Mergers and acquisitions make becoming a mega within reach of a large number of large regional players. For example, the recent merger of Thomas Cook and Crimson/Heritage created one of the five largest agencies in the United States. Information is not available to evaluate the profitability of these acquisition strategies. It is possible that acquisition premiums are high enough to erode any increased current profitability from the combinations. At the same time, the increasing rate of consolidation in the industry is clear evidence that the expectations of future scale economies and the current size distribution are not yet balanced. It is too soon to identify the ultimate survivors.

Continuing consolidation raises another issue. The TA industry still must be considered relatively fragmented, despite the rate of consolidation. And the consolidation is now expanding globally. It may be that the level of growth needed to stay at the top of the pack in the industry is higher than the level of growth possible through the internal expansion RT has relied on in the past. Acquisitions may be necessary for survival. RT is not necessarily disadvantaged in an acquisition game; their systems infrastructure may give them an advantage in integrating acquired operations, allowing them more rapidly to exploit the additional scale. On the other hand, Rosenbluth's family ownership may be a liability in the future for gaining access to the capital necessary to finance acquisitions.

Finally, technology may ultimately reduce the competitive benefits of size. Consortia and franchise networks have been around in the industry for some time. In fact, the

ten largest consortia account for over $32 billion in air sales. There are clearly some problems with the consortia concept as currently practiced, evidenced by considerable turmoil in membership and a leveling off of growth [3]. However, it is possible that cooperative networks can be viable over the long term, particularly with advances in technology and the development of management techniques for cooperation [8]. In fact, RT is relying on a cooperative approach, the RIA, for global expansion.

4.5. Organizational Factors

The importance of resources such as scale of operations, information, expertise, and IT depend on the effectiveness with which they are utilized. Such organizational issues as culture, management style, incentive structure, and leadership ultimately determine the outcome of the competitive game. Here, RT is more than well situated.

Few large competitors possess the coordination and consistent focus of RT. In most cases, such as those of USTS and Cook/Heritage/Crimson, problems arise from trying to integrate acquisitions with very diverse systems, cultures, and strategies. RT is extremely concerned with organizational, strategic, and technological coordination. This can be seen readily in their extensive search for compatible organizations in forming the RIA, and also in the technological infrastructure put in place to coordinate the alliance. RT also possesses an innovative capability that stems from a combination of these organizational factors. While the causal relationships may be unclear, the effects are very evident. No competitor can boast the rate of innovation RT maintained over the 1980s.

4.6. Competitive Position Summarized

Rosenbluth's strategy has clearly been successful in projecting them to the head of the competitive pack over the past ten years. They successfully exploited the emergence of the corporate market to enter (and to help establish) the new strategic group of mega agencies. Over time, technology and scale economies have built substantial entry barriers to this strategic group. Information technology has played a critical role in this, both by enabling value-added services that differentiated RT in the market and by leveraging emerging scale economies in the industry.

The majority of agencies cannot surmount these barriers. However, RT's position is far from secure. Threats are emerging to the critical resources of scale of operations, technology, information, and expertise. What is certain is that IT will remain critical in the evolution of the industry. By focusing on IT for the past ten years, RT may be in a better position to jump into the next decade.

5. Conclusions: IT and Competitive Advantage

THE STRATEGIC ROLE OF IT HAS OCCUPIED RESEARCHERS for some time, and several theories and frameworks have been put forth to advance our understanding of this role. A case study is a scientifically sound method for examining these theories [11]. Of

course, no one case will establish the validity of a theory. But evidence in a case will tend either to support or to undermine hypotheses and suggest directions for enhancing the theory. The RT case allows us to make several observations about the strategic use of IT.

5.1. Exploiting a Discontinuity

Clemons [5] hypothesized that major discontinuities in the environment create the opportunity for strategic applications of IT. This was definitely true for several well-publicized IT success stories such as the airline computer reservations systems and Merrill Lynch's CMA Financial Product. The RT case also supports this view. RT's evolution depended fundamentally on the impacts of deregulation. This discontinuity led to a dramatic increase in complexity and created a demand for a means of managing that complexity. Hal Rosenbluth correctly anticipated the importance of the corporate travel management market as well as the critical role technology would play in servicing that market.

5.2. First-Mover Effects, Switching Costs

Recognizing an opportunity is merely the first step in competition and is not the same as exploiting it. McFarlan [12] suggested that the IT innovator will capture the market and maintain an edge through first-mover effects and switching costs. Clemons later expanded this view to point out that this requires that customers adopt faster than competitors can react [6]. This "create–capture–keep" paradigm is strongly supported by the RT case.

Rosenbluth Travel has clearly been the technology leader in the industry. From the introduction of READOUT in 1983 to the recent rollout of USERVISION, RT has continually utilized IT to up the ante in service innovation. Even innovations such as route-by-route fare negotiations with carriers were heavily predicated on an IT base to support the negotiation and monitoring of these programs.

Rosenbluth's innovations fueled dramatic growth through the 1980s, with sales increasing from $40 million to $1.3 billion. Most of this growth came at the expense of "Mom and Pop" agencies. During this period, competitor reaction was surprisingly low, even among the giants and the other large agencies that made the jump to "mega" during the decade. Only in the past two years have significant competitors seriously invested in closing the technology gap.

The growth in sales will likely continue as the industry consolidates further. Moreover, RT's customer base appears reasonably secure against competitors, even if not totally due to switching costs. The importance of switching costs is ambiguous. Switching costs seem to be increasing in the industry, as TAs and clients form more long-term and complex interrelationships, and IT clearly plays a role in this by enabling services that create significant economic benefits from closer integration and by establishing mechanisms for managing the more complex interactions. At the same time, most of the monetary switching costs are usually paid by the new TA, indicating

they have not yielded significant bargaining power. And IT is also becoming more important in reducing the switching costs, through easier data conversions and standard interfaces.

More important than switching costs in holding and expanding the market share gains from innovation is the role of IT in creating and exploiting economies of scale. Even firms of comparable size will continue to be at a disadvantage unless they can match RT's integration and coordination.

5.3. Using Systems to Leverage Critical Resources

We have posited that competitive advantage through IT is not simply a matter of technology leadership [7]. Even though competitors may duplicate a technology innovation, relative advantage can be created and sustained where the technology leverages some other critical resources [7]. At first glance, the RT case does not seem to support this view. RT in 1980 did not possess any significant resource advantage over other reasonably sized agencies. However, RT does appear to have used their initial technology lead to expand, acquiring key resources such as size, information, and expertise. Currently, RT has a significant resource advantage over all but a handful of competitors, even if they were now to obtain identical access to the technology.

Information technology can itself emerge as a critical resource that can be leveraged strategically. This can occur when applications build on previous applications to the point where a strong systems infrastructure emerges. Such a technology platform can drastically reduce the costs and development times of future innovations or responses to competitive moves. RT has successfully integrated its IT investments to yield a consistent IT infrastructure.

The RT case clearly demonstrates the importance of infrastructure. RT's technology push in the 1980s was oriented around the concept of a technology platform. Most competitors, when forced to react to RT innovations, chose to do so with ad-hoc, stand-alone systems. This has made it much more difficult for them to respond to more recent competitive developments. For example, TAs have recently begun to offer rechecking of lowest fare and waitlisted seats between the time of reservation and time of flight. This is typically accomplished by repeated automated queries to the CRS. The CRSs are in the process of responding by changing their fee structure to make such systems prohibitively expensive. RT, on the other hand, is building farechecking and waitlist checking functionality into their ULTRAVISION system. ULTRAVISION was developed in a negotiated and approved partnership mode with the CRS and allows a direct interface to the CRS, reducing the processing load on the CRS host, and is integrated with RT's internal infrastructure.

5.4. The Role of Vision and Culture

The importance of leadership and vision in the success of strategic applications of IT has been recognized [2]. The RT case clearly supports the importance of these "soft" factors. RT's success would not have been possible without the vision of Hal

Rosenbluth, as well as the people and organizational environment he assembled to implement that vision. It took the technology expertise and vision of David Miller to translate Hal's business vision into feasible strategies and systems. And it took the aggressive service and innovation orientation of the RT culture to make these strategies successful. The leadership and people enabled RT to emerge as a national mega, and will undoubtedly be important in the continuing competitive game.

NOTES

1. These are company figures. Rosenbluth Travel is privately held and does not publish financial results.

2. TAs earn revenues from other sources, but air sales are typically the largest revenue item. These figures are the most reliable and complete indication of travel agency sales available.

3. Numbers compiled from industry sources by Advanced Distribution Technologies, Inc., in Framingham, MA.

4. This is a somewhat simplistic summary. The airlines originally intended TAs to be captive agents augmenting internal distribution systems. Competitive and regulatory forces led to a gradual opening of the systems that continues to this day. Moreover, the complexity of route and fare structures and the technology to manage that complexity are fundamentally interrelated. See Copeland and McKenney [9] for an excellent discussion of these issues.

5. Fares negotiated by route are a very small percentage of special fares. According to Hal Rosenbluth, RT pioneered this practice and still accounts for the majority of such arrangements, although other large agencies have recently begun to offer similar deals.

6. Numbers compiled from industry sources by Advanced Distribution Technologies, Inc. in Framingham, MA.

7. While the READOUT database was available to Rosenbluth reservations clerks, through the CRS, this product was totally proprietary. The CRSs all offered special private data areas that could be defined and used by the TA. They also provided simple functions for viewing such private data. RT maintained the READOUT database in this private data area and used CRS functions for making it available to the reservation agent.

8. The exclusive reliance on Covia's Apollo is temporary. Covia (U.S.), Galileo (Europe), and Gemini (Canada) have entered into a federation to provide a global reservations systems network. The goal is to have common interfaces and transparent access to any of the three participants' systems. The RIA is working closely with all members of the federation. Eventually, as is the case with RT in the United States, the RIA will support all major CRSs.

9. American Express has a global network, but it does not support comprehensive coordination of travel services or data. For example, an American Express office in London would not necessarily have access to itineraries, traveler profiles, or corporate policy information from another Amex office.

10. Only one CRS in the United States is now wholly owned by a single airline. Moreover, CRSs in Europe and Asia are all co-owned by multiple airlines.

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Rosenbluth International: Transformation of an Enterprise in a Turbulent Environment

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Introduction

Over the past two years, the environment in which travel agencies and their corporate customers interact has undergone fundamental changes, which include the airlines' introduction of commission caps and cuts, the appearance of online travel agents, and the advent of automated travel management systems. Of these changes, the ones most immediately felt by agencies were the introduction of commission caps in February 1995 and the following commission cut in October 1997. In this paper, we investigate how an established player — Rosenbluth International — reacted to these changes by dramatically transforming its value proposition, its fee structure, and its relationship with its key accounts.

While it is not unusual for a new player to benefit from the opportunities created by a strategic discontinuity, this is extremely rare and difficult for an established player whose success was closely tied to the previous competitive environment[1]. The biggest obstacles are often self-imposed upon the firm by behavioral limitations of its own management team, rather than a result of strategic actions by competitors.

As Hal Rosenbluth notes, "Many of us experienced the deregulation and the computerization of the 1980s. This next decade will be much more challenging. Many industry participants, even many apparently strong agencies, may not survive. They just won't be able to redefine their services or their customer value propositions." Danamichele O'Brien, Vice President and Chief Travel Scientist at Rosenbluth International, adds, "Although adjusting to this has been extremely difficult for many agencies, she feels that "The duty for Rosenbluth International was clear: create more value."

Background

This section briefly reviews the structure of the travel agency and air travel industry[2].

Before airline deregulation in 1978, travel agents did not distinguish between business and leisure travel. In these times of price stability and slowly increasing computing power[3], travel agencies had no means to differentiate their service while competing with each other, and had little to offer their corporate accounts. Commonly, the travel agents' role was seen in their advising and destination-based expertise, while the airlines' ticket offices would procure the tickets for corporations.

This rapidly changed after deregulation and the rapidly increasing availability of information technology. Travel agents shifted from

1 For example, IBM was completely unprepared for mini computers, which represented an innovation by Digital Equipment, who in turn did not foresee the PC revolution. General Motors and Ford failed to anticipate the American public's shift to smaller, more fuel efficient vehicles during the oil crises of the 1970s. Another example closer to travel is American Express, which was much larger and more successful than Rosenbluth in the 1970s, but which was not initially able to benefit as rapidly as Rosenbluth from the airline deregulation in 1978.

2 For a more detailed description, see Clemons and Row [6].

3 SABRE, American Airlines' computer reservation systems (CRS), was introduced to the first travel agent in 1976 .

principally supporting leisure travel with coaching on choice of destination, to increasingly supporting corporate travel with the responsibility for price control, negotiation of preferred fares, and preparation of travel activity reports on behalf of or in cooperation with their corporate customers.

During this period, Rosenbluth International pioneered the sequences of strategic change in the travel industry and benefited from it disproportionately. Rosenbluth grew from the largest — primarily leisure oriented — travel agency in the Philadelphia area with $40 million in air sales in 1979 to a predominantly corporate travel oriented agency with over $3 billion in air sales and over 4,500 employees in 26 or more countries throughout the world in 1997.

While Rosenbluth's initial advantage was based on point of sales tools and fare search engines, seamless linked to back office reporting and inquiry systems, these initial advantages have been eroded by competition. Rosenbluth's value proposition at present is its ability to deliver travel management services and documented savings in travel spending. This is based on a patent-pending client yield management system called DACODA (Discount Analysis Containing Optimal Decision Algorithms) which is used to shift market share from one airline to another and establish credibility in the fare negotiations with the airlines.

The Nature of Competitive Forces

More recently, the very success of this new corporate-focused strategy created the threats that jeopardized the health of the industry that Rosenbluth helped to create. Rosenbluth — as all other corporate travel agents — faces three threats to its profitability:

- rebate-based competition
- commission caps and cuts
- efforts from the airlines and CRSs to disintermediate corporate travel agents by moving aggressively to electronic distribution channels

Traditionally, travel agents have been paid principally through commissions, which were directly linked to the ticket sales each agency generated. Commissions were a fixed 10% of ticket price and were paid by the airlines on all tickets written by the agencies; there were no charges to customers and no discounts for booking directly with the airline. The increasing cost focus of airlines and corporations have worked like the jaws of a pair of pliers, together putting pressure on the travel agent's commissions. The current practices and recent developments are summarized in the next paragraphs.

Rebates

Rebating represented the first threat encountered by most major agencies in their corporate business. Some agencies, like Rosenbluth, believed that rebating would reduce the moneys available for their own investment, and thus the quality of the service they could offer their customers; thus rebating was vigorously resisted. Ultimately, however, once Carlson and Cook were rebating percentage points off their commissions, and American Express was significantly rebating from the percentage it charged airlines and service providers who accepted its corporate card, other agencies were forced to follow.

Hal explains his policy on rebating as follows: "We resisted as long as we could. We were convinced that rebating was a terrible idea, a real downward spiral for our clients as well as for us, since it was incompatible with investing in our collective future and with delivering quality service to our customers. Ultimately, however, market pressures left us no choice."

With the increasing efforts to reduce travel expenses — the third highest business expense after payroll and data processing for the average U.S. business — travel agents started competing for corporate clients by offering commission-sharing arrangements, also called "rebating." This has become common practice and before the imposition of commission caps, corporations could expect approximately a 3 percent rebate of the ticket price; since this represents 3 out of 10% commission, or 30% of the agents' gross revenue, rebates represented a significant loss to agencies.

Commission Caps and Commission Cuts

Commission caps recently emerged as the second threat to established agencies, in both

their corporate and leisure businesses. These slashed revenues, requiring painful changes.

Danamichele O'Brien argues with considerable justification that it is unfair to claim that Rosenbluth International should have seen these changes coming but they did not. Clearly, Hal Rosenbluth did not anticipate the changes in the period when his company was transforming the agency industry, moving away from principally serving the leisure segments of the industry and towards a focus on corporate travel. As Hal notes, he thought that his company was too valuable to the airlines, and too powerful, for them to attempt to do this to them. However, neither the airlines themselves nor industry analysts foresaw commission capitation as the airlines' response. Danamichele adds that the firm "underestimated the extent to which the airlines would attempt to extract value from the channel and retain it for themselves, and how little they would be willing to share, either with clients or with valued agency partners."

The brutal fare wars in the early 1990s and the loss of profits caused airlines to search for ways to increase their margins. Commissions were an expense for airlines every bit as significant as travel is for the average corporation. For airlines, commissions to travel agents constituted their third largest operating expense[4]. In addition to commissions, airlines have also paid travel agents a performance bonus called "overrides." These overrides are linked to specific geographic markets, and every travel agency that is able to meet certain market share hurdles in an individual geographic market is awarded a negotiated percentage of the revenue accumulated for that market.

While airlines expected to pay 10% as the cost of distribution for the labor intensive leisure market, they came to resent paying 10% as the cost of distribution for what they saw as relatively easy corporate business. This became an increasing concern, especially when the industry's changes shifted 80% of the corporate business to agency-based distribution. The first indication of major airlines' dissatisfaction was American's attempt to eliminate agency-based fare negotiation, which if successful would have halted the growth in power and market share of the largest agencies[5]. Although this attempt did not succeed, due to lack of cooperation from Rosenbluth and all other major corporate agencies

4 It is estimated that airlines paid $5.9 billion in commissions and overrides to travel agents in 1993, which accounted for more than 11 percent of airlines' revenue [13].

5 Mega agencies, such as American Express or Rosenbluth International, have played a critical role in developing "corporate fares." In these negotiated fare agreements between a firm and an airline (which becomes it's "preferred supplier"), the firm receives a percentage discount for tickets of that airline. These discounts may apply for all tickets sold or only to tickets for specific routes. The size of this discount depends on the volume of business or the share of its business that the firm delivers to the carrier for the negotiated period of time, where the agreement can be based on specific routings or on the firm's total air travel expenditures. (Depending on the travel pattern of the firm and the geographic reach of each airline, a firm often has several preferred suppliers.)

Rosenbluth's clients rely on their travel agents to satisfy the travel needs while minimizing costs. This is accomplished in part by booking flights so that the best possible discount is achieved, considering options available from all suppliers. By negotiating preferred fares and routing business to optimize their clients' expenses, Rosenbluth effectively moves market share from one airline to another, while increasing the competitive pressures on each airline to reduce fares by granting Rosenbluth and its clients special discounts.

American Airlines realized that this practice of allowing powerful agencies to negotiate special fares for the agencies' clients enabled mega travel agencies to exploit their strong position in the distribution channel for corporate travel services; indeed, by enabling these agencies to offer lower fares than were available to their competitors it allowed them to use their strength to increase their market share, which in turn increased their strength.

American therefore attempted to break this self-reinforcing cycle by eliminating the negotiation of special fare agreements with agencies, instead promising comparable rates to all business travelers. Rosenbluth and all other major corporate agencies understood the threat that American's actions represented and retaliated in the most effective way available to them: they booked as many tickets as possible away from American Airlines. Other carriers, especially TWA, made it clear that they would be delighted to accept the business that was being diverted away from American. American – after losing substantial market share over the short term – was forced to retreat.

other carriers, it made at least some industry participants aware that airlines were less willing to continue with the current industry structure.

In February 1995, Delta Airlines introduced the cap of $50 on the 10% commission for all domestic tickets. This move was immediately followed by all other major airlines. In October 1997, United Airlines went even further and cut the commissions to 8% or $50, whichever is less. This cut alone will save the carrier an estimated $80 to 100 million annually. Again, this move was followed in cascading fashion by three dozen airlines around the world. Many industry observers speculate that further commission caps and cuts are possible, especially for international flights, which — until a recent move by British Airways — had escaped the previous rounds unscathed.

The Disintermediation Threat

Disintermediation — the bypass of travel agencies and the reduction or elimination of their role in the distribution of travel services — represents the third threat to the profitability of agencies and to the continued existence of their business. This threat is still emerging, but could prove to be the most dangerous of the three. Direct distribution systems are being introduced, with ever-increasing ingenuity. Disintermediation of corporate travel agents has been slow to catch on, but the advent of new technologies, such as interactive video, may greatly accelerate this trend; as noted in the business press, "the growth of online booking services and the development of interactive television could, at least theoretically, eliminate the role of travel agents altogether.

Indeed, preliminary analysis might suggest that disintermediation is a real threat. Some customers are just too easy to serve, and the airlines have decided that they are unwilling to pay agencies 10% commissions for serving them. This, in turn, suggests that corporate agencies will need to learn to deal with the threat of airlines selling directly to their corporate accounts. Moreover, it suggests that the leisure business is vulnerable in a different way, with the internet providing service to leisure travelers who want tickets but do not need advice, and with a whole host of new distribution mechanisms all competing for different segments of retail customers.

Danamichele O'Brien disagrees with this analysis. She believes that "the *disintermediation craze* that was fueled by the internet will prove to be short lived and misdirected." She goes on to explain, "It was short lived because Rosenbluth International quickly adopted this new form of 'EDI' to connect to its clients." That is, she believes that disintermediation is not a threat, since reintermediation rapidly followed. She believes that the fear of disintermediation was misdirected, because "It was not the value-adding travel management functions of the agencies that were in danger of being disintermediated so much as the more traditional, pure distribution functions of the travel agencies and many of the functions of the CRSs. This, too, was short-lived as the CRSs have learned to harness internet capability."

Driven by the World Wide Web's promise to provide a cheaper channel, computer reservation systems, travel technology vendors and airlines have devoted considerable resources to grow the corporate online segment. It is estimated that $15-$20 cost savings per ticket can be gained just by booking online and using e-tickets; this savings can be split by the involved parties. Consequently, airlines, CRSs and technology vendors have developed products for electronic distribution to corporate clients; these range from self-booking capabilities with the ability to enforce corporate travel policies to expense reporting and information management.

First indications show that electronic distribution is a viable channel. For example, United Connection — United Airlines' electronic booking system — is averaging $11 million a month in sales and captured about $115 million in sales for 1997, for which neither travel agency commission nor overrides had to be paid. This more than doubled the online sales of $43 million in 1996. An equally prominent example is AXI (American Express Interactive), a corporate self-booking program, developed by Microsoft and American Express. Six months after the first roll-out, American Express had installed AXI software for 20 corporate customers, which represented $600 million in annual airline ticket sales.

A few travel managers have also started to negotiate deals with airlines directly to obtain

"Internet-only fares" that are cheaper than the best available fares elsewhere for their corporations[6]. Attempts to share these costs savings remain relatively rare. Estimates from industry sources suggest that currently only about one-third of one percent of corporations have such deals. But if low-cost electronic reservations were combined with electronic ticketing and interline capabilities, this could increase significantly in the near future.

In order to increase adoption rates by corporate clients' employees, airlines are courting corporate travelers with soft-dollar agreements. They include such value-added perks as bonus miles or points, vacation discounts, and private versions of the popular weekend deals available on consumer sites. For example, United is offering a small incentive — 1,000 frequent flier miles per round trip.

Airlines and CRSs are positioning themselves in the online travel market and have taken steps that limit competition in and future entry into the online market. In the summer of 1997, major airlines began capping commissions to online travel agents and, in some cases, offered straight flat rates to agencies. Northwest and Continental Airlines cut commissions to 5% or $25, whichever is less. American Airlines and United Airlines went even further and now offer only a flat fee of $15 and $10 respectively for each transaction. CRSs, on the other hand, have increased fees for browsing that does not turn into a purchase[7]. The reduction of the revenue base and the increase in operating expenses make it very unattractive to become an online travel agent and have already forced one online travel agent out of business. PC Travel, one of the earliest entrant in the online travel market, closed in the summer of 1997, after three years of service.

While commission caps and cuts apply to all tickets sold, the disintermediation efforts are targeted only to the attractive customer segment; the *love 'ems* as they have been termed in earlier work. Using this framework, *love 'em* customers are the most attractive business travelers. These are experienced travelers, who usually need only limited advising, and who frequently already have a specific flight in mind before they approach the travel agent. They are usually technology savvy and have the installed technology base to use electronic booking systems. While these customers are the easiest for the agencies to serve, they are also the most profitable ones for the airlines[8]. Hence, airlines have had two incentives to attempt to establish and foster a direct relationship to these customers:

- To remove the agencies ability to reroute this travelers to other carriers, as part of a program to maximize the savings from negotiated fares

- To capture the commissions that were paid to agencies for serving these travelers, which frequently amounted to little more than directing them to the lowest cost fares

Frequent flier programs and upgrade policies based on customer history are successful attempts that at least partly serve this purpose and illustrate the sophistication that airlines have achieved in their efforts to establish strong links with individual travelers; increasingly, these may play a role in their efforts to disintermediate the travel agent's advising role.

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6 These corporate internet fares are distinct from the majority of internet-only fares, which are heavily restricted, available only at the list minute, or in other ways not suitable for business travel. Indeed, most internet-only fares can be dismissed by travel professionals as "garbage fares."

7 This is especially damaging to online travel agents, since many Web users look at their options via the net, but do not actually make any travel bookings. Estimates of the *booker-to-looker* ratio vary widely. Numbers are especially unattractive among the leisure segment; according to a recent survey by the advertising agency BBDO Worldwide, only 15 percent of people who use the Internet to get information end up booking their tickets online, while Jupiter Communications estimate that it requires 74 inquiries to yield one booking. In contrast, the corporate looker-to-booker ratio may merely be three-to-one.

8 It is estimated that for TWA the 25% most profitable customers account for 50% of its revenue; that number, while impressive, is the lowest for all major airlines. For Delta, the 9% of its most profitable customers account for roughly 45% of its revenue.

On the other hand, there are numerous retail travelers who travel only infrequently. These travelers often need considerable coaching, and they are much less likely to select their own flights, or even their leisure destinations without assistance. They also often lack the familiarity with recent technological innovations needed for them to feel comfortable using an electronic booking system. This segment would represent the *kill you* customers if airlines tried to attempt to serve them themselves; they are expensive to serve and are also cost-conscious. Consequently, airlines will try to leave serving these customers to the travel agents.

Rosenbluth's Competitive Situation

Hal Rosenbluth — President and Chief Executive of Rosenbluth International — is a strong believer in open communications and has created a corporate culture with close relationships to clients, suppliers, and Rosenbluth employees. Hence, he was acutely aware of the looming changes and its potential consequences. In his own words, intimate knowledge about industry changes are important, to be able to "define the playing field that you can win on."

Hal was looking for an answer to two questions:

- What customer should Rosenbluth serve?
- How should Rosenbluth be compensated for its services?

Rosenbluth's Customers

Rosenbluth's organization recognizes two types of customers: leisure travelers and corporate travelers.

Rosenbluth International has been in the leisure business since its inception in 1892, which created a legacy of commitment to the leisure sector. Much of the Rosenbluth's folklore is based on the tales of Hal's grand-grandfather who founded Rosenbluth Travel.

However, retail travel seems to be the most vulnerable market, since airlines and CRSs can cream skim the few *love 'em* leisure customers among the many *kill yous*. Once cream skimming begins, with the new commission cap and cuts in place, a profitable leisure business may be forced to start charging its remaining customers for services simply to cover the higher operating expenses associated with this segment of the business. However, customers who do not need much service would predictably resist these fees, as they could easily bring their business elsewhere, while the most service-intensive customers would remain with their leisure agencies. As more of the easy-to-serve customers depart, leisure agencies would be forced to raise fees again, leading to more loss of the remaining relatively easily served customers. Avoiding this "death spiral" would require an entirely new pricing strategy for the retail business.

The corporate travel segment has been accountable for the formidable growth that Rosenbluth International has experienced in the 80s and early and mid 90s. Hal formed the first corporate reservation center in 1981 and he was mainly responsible for Rosenbluth's tremendous success. While leisure travel was a big part of Rosenbluth's history, it was the corporate travel market that defined the playing field that Hal has won on. Hal was so successful, that in 1998 the corporate market accounted for 95% of business volume and for an even higher percentage in terms of profit.

Corporate customers vary widely in their needs. Some of them turned to Rosenbluth International for cost control reasons; they were attracted by Rosenbluth's economies of scale and expertise to negotiate airfares with the airlines. These clients tended to be suspicious of the compensation scheme; since all travel agents earn a percentage of the ticket price, they have an incentive to sell a higher priced ticket. This has often been an issue when negotiating a contract with Rosenbluth and Hal and his colleagues spent much time and resources to convince existing and prospective clients that Rosenbluth is their agent rather than the airlines' agent.

Other clients relied heavily on Rosenbluth for its superior service. These clients appreciated Rosenbluth global network and the ability to talk to a Rosenbluth representative in 26 countries. Travelers from these clients often make last minute changes to their itinerary and have a need for someone to coordinate their travel plans.

Rosenbluth International negotiates the desired service levels with their clients. The service level is often defined in terms of percentage of calls that are answered in a certain period of

time[9] and higher service levels require more staff allocated to the client's needs. Other services can include advisory services and consultation to lower costs, development of travel policies, negotiation of preferred supplier rates, enforcement of travel policies, provision of international service capabilities, and assistance in planning group meetings.

Rosenbluth's Compensation Structure

Intensive discussions with suppliers and clients made Hal Rosenbluth aware that both markets viewed travel agents as overpaid; neither corporate customers nor airlines believed that they were receiving significant value from travel agents, or that agencies were adding sufficient value to justify the commissions that airlines were paying them. After some reflection, he conceded that he had overvalued his company and its services; "I thought that we were more valuable than we were." He recognized that

- The airlines were paying agencies more than the airlines benefited from their work
- Airlines do not owe TA a living, even though many agents appeared to believe they do
- Airlines will bypass travel agents when they believe that it is in their economic interests to do so, if they believe that they can

In brief, Hal came to recognize that airline executives believed that it was their responsibility to their shareholders to maximize yield and revenue, and that they would squeezing travel agents if it proved necessary to do so. It would be the travel agents' responsibility is to find ways to add value for customers, so that the airlines would be unable squeeze agencies further; customers would not allow it to happen.

Hal also realized that Rosenbluth's compensation was more determined by the bargaining power and experience of the client than by the service level that Rosenbluth provided. Customers with higher service needs have often, but not always, received a lower rebate than customers with lower service needs. This was partly due to the bargaining power, but also due to the fact that Rosenbluth has only rudimentary knowledge about the true costs of its services.

Further, Hal realized that airlines, CRSs, technology vendors and new start-ups have used the WWW as a new distribution channel of tickets. While these new entrants have not been able to come even close to the service offerings of Rosenbluth International, Hal feared that he would loose some of the cost-conscious clients to the promise of 'automated' travel reservations.

In this new environment, Hal had to take measures to adapt to the changing environment.

9 A standard rule is the 80/20 rule; 80 percent of calls have to be answered in 20 seconds.

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Introduction to Software
OPIM 210

Il-Horn Hann

CPU Comparison (Add on)

Processor	# Tran-sistors	L1 cache	Process Techn.	Note
Pentium	3.1	16 KB	.6 micron	System bus width is 64 bit and the speed is 60 or 66 MHz
Pentium Pro	5.5	16 KB	.35 micron	The new hot feature was that the L2 cache (256KB/512KB) is built-in
Pentium MMX	5.5	32KB	.35 micron	57 new integer instructions, four new data types, and eight 64 bit registers
Pentium II	7.5	32 KB	.35 micron	it is a partially reduced and partially improved Pentium Pro model

Basics of software

- Software programs are the instructions that tell computers what to do
- Software is written in a computer language which is converted into instructions that a processor can understand

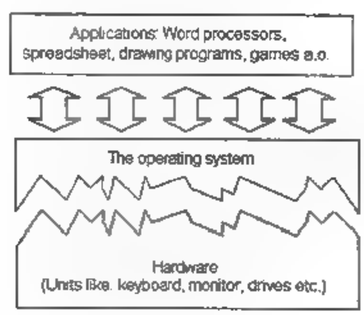
Software Hierarchy

- Operating systems
  - Low level (BIOS)
  - High Level (ex. Windows NT)
  - Systems Utilities
- Programming languages
  - Compilers, interpreters, linkers, development tools
- Applications software

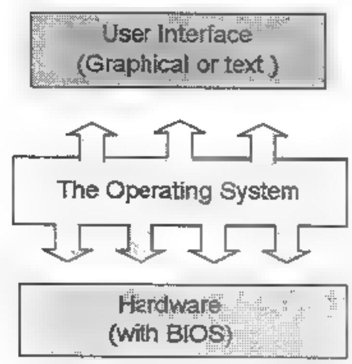
Operating Systems

- Controls how users and other programs programs interact with computer hardware
  - Examples:
    - Mainframes: MVS, VM (IBM)
    - Mac: System 8
    - PCs: Windows NT, Windows 95, OS/2, DOS
    - Workstations: Unix
- OS consists of three parts
  - Kernel
  - Shell
  - File system

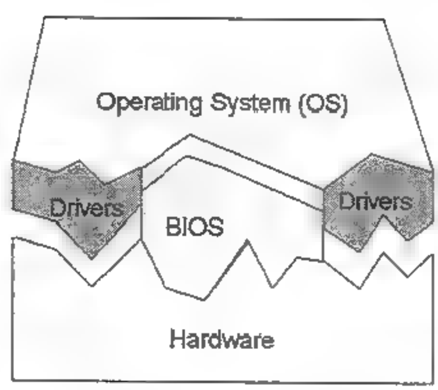
The OS as a program layer



The OS and system software (BIOS)



Communication between OS and Hardware



Operating Systems - Tasks

- Resource scheduling and management
  - Processor: multitasking, multithreading
  - Memory: Virtual memory
- Job management
  - Job accounting, initiation, termination
- I/O management
  - May include managing user interface

OS Issues

- User interface
  - Command line (DOS, basic UNIX)
  - Graphical user interface - GUI (Windows 95)
- Sophistication in handling external hardware
  - Plug n' Play (Windows 95, Mac OS)
  - Hardware configuration/specialty drivers
- Legacy constraints
  - Length of file names, size of address space, allowed disk sizes...

Programming Languages

- Programming languages provide a way of specifying computer instructions using a more intuitive set of commands
  - Interpreted - a language interpreter translates the program into action steps as it runs (ex: Original Basic)
  - Compiled - the program is converted directly into machine code and runs without additional assistance (ex: C)
    - » Actually: first compiled into *object code* which is *linked* with other programs to create an *executable*
  - Hybrid - JIT as the interpreter starts to run the program, it also has the ability to translate it to native code and run that (ex: Java)
    - » May someday combine best of both, but right now performance is somewhere in the middle

Languages - Generations

- First Generation - Machine Code
  - ex: 1A2F3CFF....
- Second Generation - Assembly language
  - ex: MOV DX, (3C00H)
- Third Generation - "High Level Languages"
  - ex: Integer A; Let A=1; A=A+1;
- Fourth Generation
  - ex: SELECT CUSTOMER FROM CUSTFILE WHERE INCOME>100000

Languages in use

- COBOL
- Fortran
- Basic
- Visual Basic
- C/C+
- C++
- LISP
- SAS
- SQL

Some other languages

- Spreadsheet macros
- Database systems
- Data or graphical description languages
  - HTML - Hypertext Markup Language
  - Postscript - a printer control language
- CASE tools
- Scripting languages (e.g. JavaScript)

Special languages - CASE

- CASE (Computer Aided Software Engineering)
  - Defintion: A vanety of tools that automate some or all of the programming process
    - Lower case: screen design utilities
    - Upper case: programs that translate process descriptions into usable programs
  - Types of tools
    - process mapping, code generators, screen generators, data description language
- Died out after being over-hyped, but tools still remain
  - However, the term CASE still carries some stigma and is not as commonly used

Special languages - object oriented programming

- OOP - A way of creating modular code embodying several principles
  - encapsulation
    - an instance of "information hiding"
  - inheritance
  - polymorphism
- Intended to improve programming efficiency and encourage reuse
- NOT the same as a graphical user interface, although the two often appear together
- Example: C++

Three principles of OOP

- Encapsulation

```
class rectangle {
   int length;
   int widht;

   int clalculate_perimeter() {
      return 2*(length + widht);
   }
}
```

"rectangle" becomes a data type
e.g. declare variable
rectangle mybox

- Inheritance

```
class square extends rectangle {
   double diagonal() {
      return Math.sqrt(2.0)*length;
   }
}
```

can reuse to redefine to new data type

Three principles of OOP

- Polymorphism

```
class square extends rectangle {
   int clalculate_perimeter() {
      return 4*length;
   }

   double diagonal() {
      return Math.sqrt(2.0)*length;
   }
}
```

- Usage at runtime

```
rectangle r;

if condition
   r = new square();
else
   r = new rectangle();
```

Language Issues

- Compatibility
  - Languages have many dialects, many of which are not interchangeable
  - Multiplatform support is available for some (e.g. Visual Basic, Java) - *vertical compatibility*
  - Adaptations
    - Cross-compilers
    - Code translators
    - Code analysis tools
  - Translation of older languages into modern versions (e.g. mainframe to PC) is a substantial barrier in converting to PC or client server systems

Language issues

- Programming toolkits
  - Most programming languages are sold with a variety of tools
  - Can include:
    - Editor
    - Compiler
    - Debugger (allows flow simulation)
    - Linker (where needed)
    - Code analyzers (performance, complexity, flowcharting)
    - Code libraries (common routines, screen objects)

Language Issues - interoperability

- DDE (Dynamic Data Exchange)
- OLE (Object Linking and Embedding)
- Active X (A variant of distributed OLE)
- API (Application Programming Interface)

Applications software

- Too numerous to name...
  - Office automation (word processing, spreadsheet, workflow)
  - Manufacturing automation (MRP, CAD/CAM, CNC tools, inspection systems, inventory management)
  - Marketing systems - customer information systems, data mining tools
  - Decision support - DSS, EIS, activity-based accounting systems, profitability systems
- Recent emergence: applets

Hot Topics: Year 2000 Problem

- Many programs were written only allocating 2 bytes to store the year
  - e.g. 87 instead of 1987
  - Fine until we hit year 2000
  - Particularly problematic for legacy systems in COBOL or whenever database fields are "hard coded"
- Problem is pervasive
  - Estimates vary widely but are in the billions
  - Creating a cottage industry of "Y2K" software companies + major systems houses (e.g. Andersen, CA...)
  - Repair is labor intensive
    - » Code analysis tools only go so far
    - » Rewriting code where there are no specs & years of updates

Development Options

- Develop in-house
- Contracted
  - Analysis and Design
  - Coding
  - Implementation
- Outsource
- Packages
  - including adaptations
  - templates
  - component-based software (objects for sale?)

Software pricing

- Traditional pricing
  - Unlimited use license
  - Limited time license
  - Site-licenses
  - Quantity discounts - network versions
- Application Suites/Bundles
- Pay for use
- Shareware
- Freeware
- Fundamental problem: how do you pnce a good with a marginal cost –> 0

Operating system extensions

- Communications
  - ex: CICS
- Network operating systems
  - ex: Novell Netware, NT Server
- Database management systems
  - ex: SQL server
- System utilities
  - ex: Format utility

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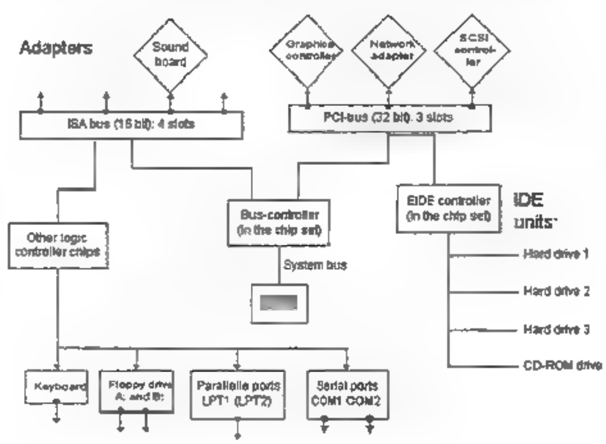
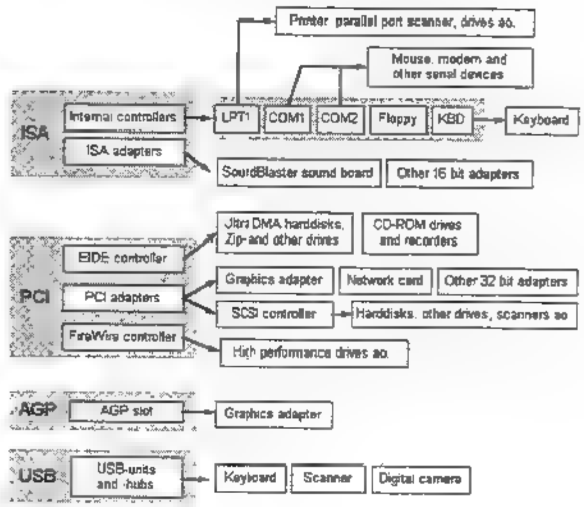
Hardware
OPIM 210 - Lecture 7

Il-Horn Hann

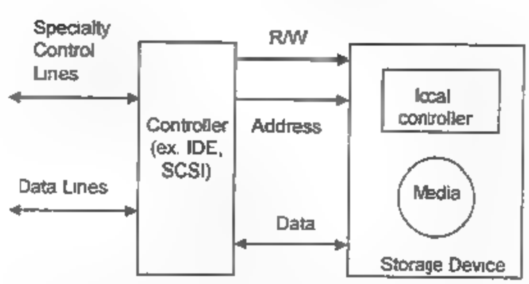
The data flow on the motherboard



Overview of I/O-buses

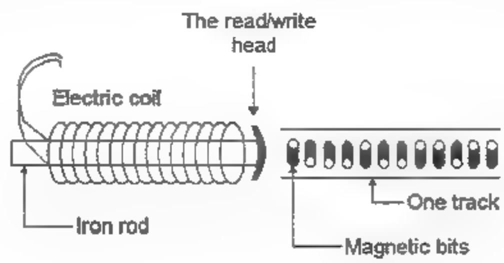


Mass storage



- Relatively slow, high capacity storage
- Major examples: hard disk, floppy disk, tape, CD-ROM
- Others: Optical, Magneto-Optical, Semiconductor
- Historical: paper tape, punch cards, cassette tape

Reading/writing on a hard disk

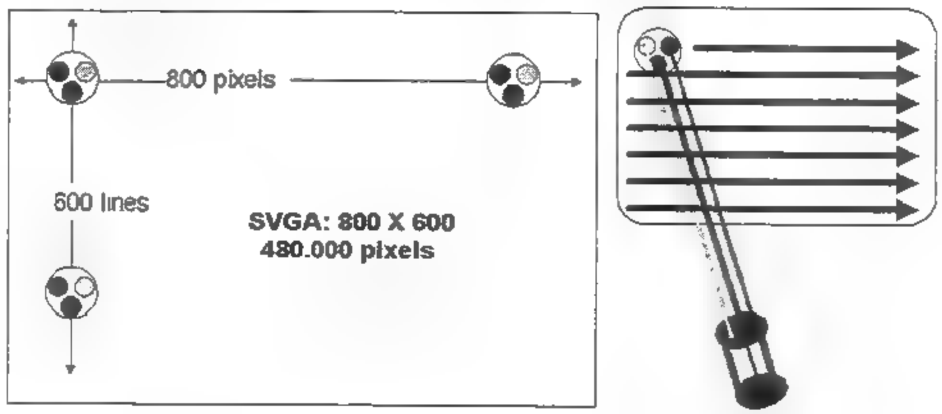


What the magnetic bits mean...

Mass storage issues

- Speed determined by multiple factors
  - Channel speed (IDE vs. SCSI)
  - Bus Speed (ex. ISA, EISA, PCI, VL)
  - Seek time (latency, interleave, track-to-track time)
  - Software drivers
- Trend: high capacity removable systems
  - Zip and Jaz Drives
  - Non-volatile silicon devices gaining popularity

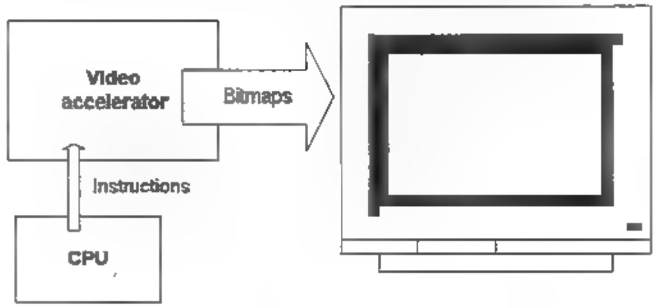
How a display works



Output devices - Video

- Video
  - Monitors: interlaced vs. non-interlaced, dot pitch, scan frequency
  - Flat panel: active vs. passive matrix, size
  - Video accelerator cards: memory, processor, compression (MPEG), software drivers, data transfer rate
- Trends
  - Intelligent controller cards
  - Large, flat monitors
  - Large semiconductor screens (14” Active Matrix)

Video accelerator cards



Video - Compression

- Video images take enormous amounts of space
  - single 1024 x 768 image in full (24 bit) color = 2MB
  - refresh rate at 30 Hz = 60 MB/second
- Different compression strategies
  - Video: MPEG - skip frames and interpolate
  - Still: JPEG - trade size and quality
  - Most video/audio based on lossy compression
- Hardware compression often faster/better
  - May be only way to do real-time compression
  - Compression algorithms still developing

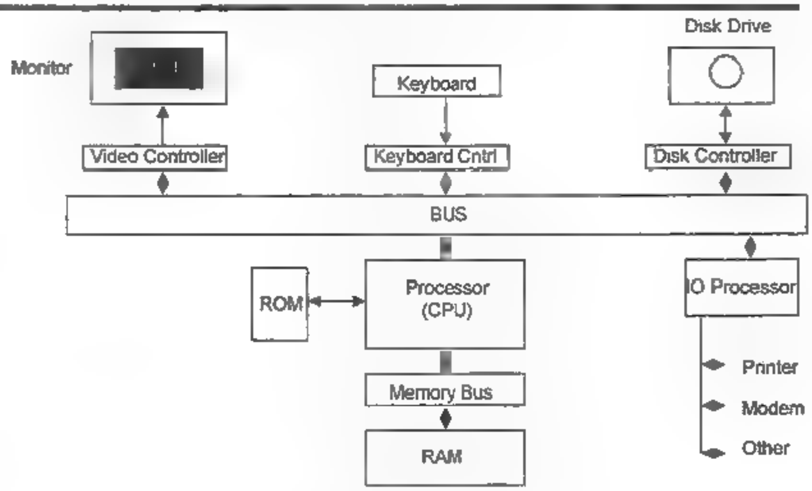
Output Devices - Printers

- Dot matrix
  - Inexpensive but moderate print quality
  - Can be extremely fast
  - Color not remarkably more expensive then BW
- Ink Jet
  - Inexpensive, better print quality, low-cost color
  - Trend toward increasing sophistication and speed
- Laser
  - High quality (600 dpi common), can be fast (20ppm)
  - Color is still expensive but price is falling

Input devices

- Keyboard
- Mouse
- Pen
- Joystick/Game pads
- Digital camera
- Digital audio
  - Voice recognition
- Scanners
- Speciality devices

Putting the parts together: Systems



- Simple PC (typical around 1990)

Types of systems

- Supercomputers
- Mainframe computers
- Minicomputers
- Workstations
- Personal computers
- Specialty computers (JavaStation?)
- PDAs (personal digital assistant)

Architectures

- Mainframes
  - Optimized for moving data around
    - » Large storage devices
    - » Large numbers of users
  - Flexibility limited
  - Relatively expensive
- Minicomputers
  - General: Used for same applications where a mainframe is too much
  - Fault tolerant: redundancy, automated failure recovery (Tandem, Stratus)

Client-Server

- Mainframe - all processing centrally done
- Client Server
  - A high volume server for data-intensive activities
  - Intelligent "clients" for pre- and post-processing
- Servers for
  - departments
  - applications
  - functions

High performance architectures

- Vector supercomputers (ex. Cray)
  - Handle data in bigger chunks
  - Programming divides workload among a few very fast processors
- Parallel processors
  - MPP - multiple processors - independent - Coordination through message passing
  - SMP - symmetrical multiprocessing - Coordination through shared memory
- Historically a bad business to be in, but they are coming back

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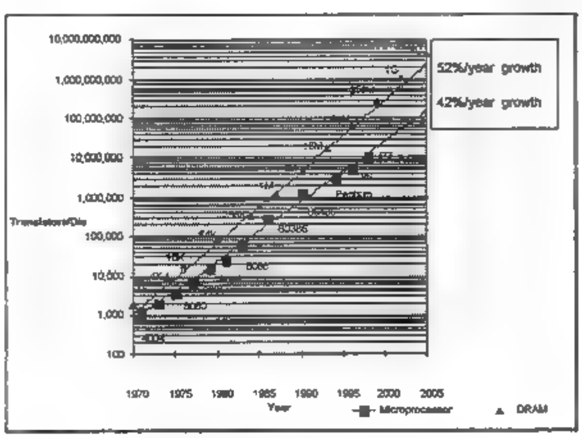
Remember Moore's law



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Hardware issues - benchmarks

- Common benchmarks
  - MIPS (millions of instructions per second)
  - MFLOPS (millions of floating point operations/second)
- Beware:
  - May not be comparable across platforms
  - System used to do test has strong influence on components scores
  - Hardware manufacturers may optimize products for benchmarks, not necessarily ordinary use

Issues: Hardware-Software Complementarity

- Value of hardware in closely tied with the value of associated software
- Trend toward increasingly complex software consumes most of the increase in hardware power
  - Example: Windows 95
- Software is not on the same technology curve
  - Hard to measure, but programming productivity is growing very slowly or not at all

- Optional exercise:
  - Tour the intel Website:
    - » http://www.intel.com/
  - For more on other types of processors check out:
    - » http://infopad.eecs.berkeley.edu/CIC/
  - For more on memory devices try Micron
    - » http://www.micron.com/
  - PC in 2001
    - » http://www.zdnet.com/pcmag/features/2001/index.html

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Files and Databases

Il-Horn Hann

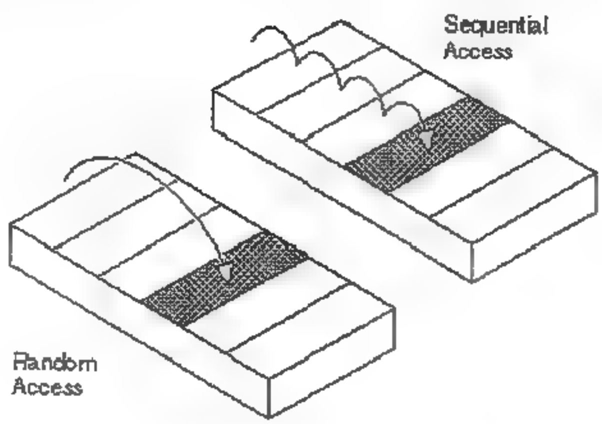
Fields, Records and Files

- Fields - a logical collection of characters (*attributes*)
- Records - a logical collection of fields, describing an *entity*
- File - a collection of records of the same type

Keys and File Structures

- Keys are used to identify records within a file
  - Primary key - unique record identifier
  - Secondary keys - used to locate records or determine sort order
- File structures
  - Sequential access - to reach a particular record, all records are scanned
  - Direct access - location of records are tracked
  - Hybrid - ISAM (Indexed sequential access method)

Sequential vs. Random Access



What you can do to files...

- Add new records
- Delete records
- Search for records satisfying some criteria
- Display information in records
- Modify records
- Generate reports

File structure determines how efficiently these types of operations can be performed

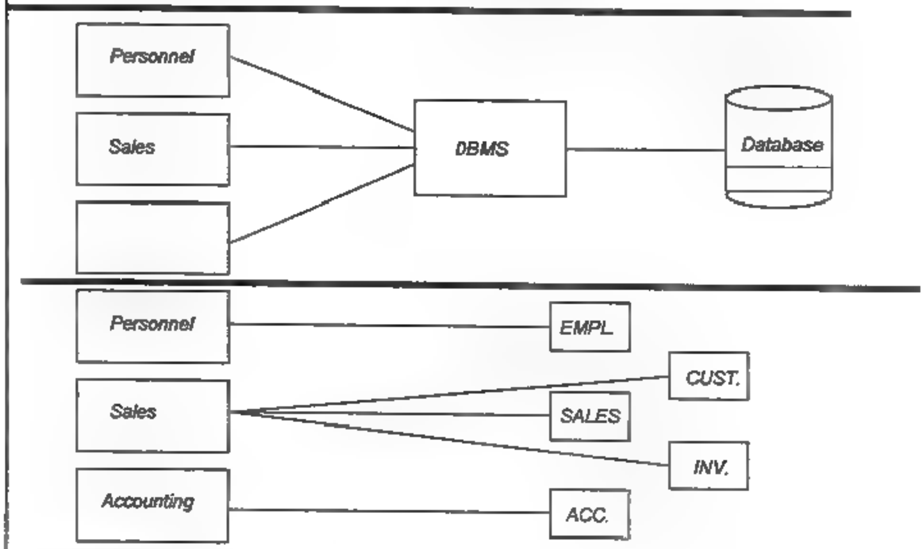
Most languages have file handling facilities

- Usually a set of commands is available to create and manage files
  - Open and close files
  - Write to a location in a file
  - Read from a file
- Problems with doing file management in programming languages
  - Limited set of facilities (lots of programming)
  - Generally does not take advantage of structured nature of the data

Solution: Databases

- Allows users and programmers to interact with the logical structure of the data, not the physical structure
  - Removes data dependence
  - Supports enforcement of consistency/integrity
  - Allows redundancies in the data to be removed
    - » Normalization

Databases vs. File Management



Parts of a DBMS

- Data dictionary (a file)
  - Describes the structure of data elements in a special language (DDL) Database Definition Language
- Query and Manipulation language
  - Allows data to be read, altered or written
  - Example: SQL DML Data manipulation Language
- Database engine
  - Translates user requests into actions on the database
- System tools
  - Used by adminstrator to manage physical database

Views of the database

- Conceptual
  - What are the basic elements and how do they relate to each other
- External view
  - Elements allowed to be seen by external programs and users
- Physical view
  - Way the database is actually stored on physical media (e.g. disk drives)

Conceptual Modeling / ER model

- Conceptual modeling is the "flowcharting" of DBMS
  - From a description of the system to a more formal description amenable to automation
  - Abstracted from the actual implementation
  - Done both for design and for documentation
- The typical design cycle
  - **Determining and verifying data requirements**
  - **Designing data structures that meet those requirements**
  - Implementing the data structures
  - Modifying and maintaining the system

Entity-Relationship Model

- World contains **entities**
  (belonging to **types** or **classes** or **domains**)
- Entities possess **attributes**
- Entities are linked to others by **relationships**

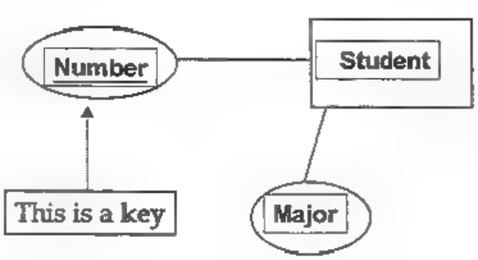
Entity

- In the ER model, a diagrammatic representation is used to depict data requirements
- Entity types are depicted using labeled rectangles.

- In programming terms, these are the data structures (classes, structs)

Attribute

- An attribute is depicted in an ER diagram by an oval
- A line from the oval to an entity indicates what entity the attribute belongs to



Keys

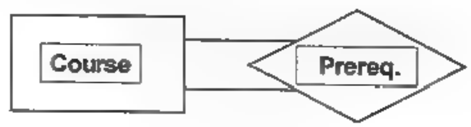
- A key is a set of attributes that
  - uniquely identifies the entity
  - is likely to be a point of access (good candidate for indexing)
  - used to relate tables in the relational model
- Technical distinction
  - a key is any unique identifier
  - a **primary key** is a key that has been identified by the designer as an identifier for the entity

Relationship (cont'd)

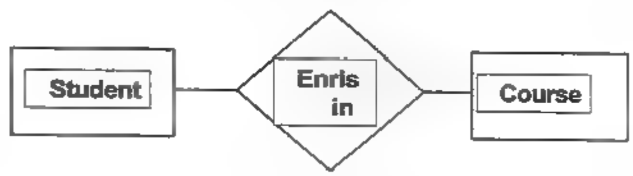
- A relationship is depicted in an ER diagram by an diamond
- A line from the diamond to one or more entity types indicates the entities participating in the relationship

Degree of a Relationship

- Degree is the number of entity types participating in the relationship
- Unary: (recursive)



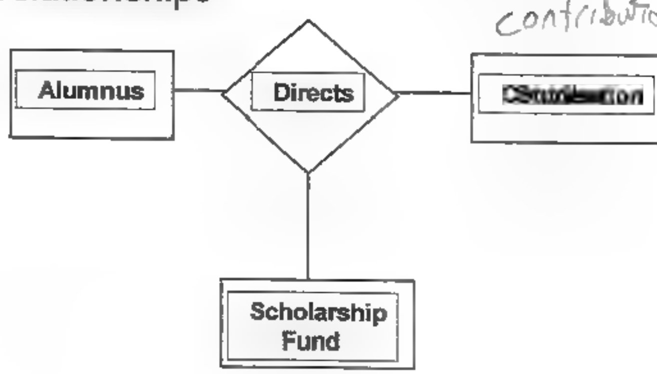
- Binary:



Degree of a Relationship (cont'd)

N-Ary relationships

contribution



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Cardinality

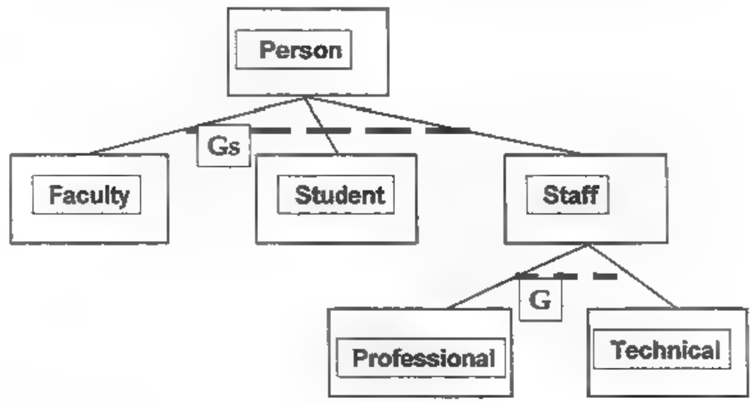
- Indicates minimum and maximum number of entities of a type that may participate in an instance of a given relationship

(min, max)

Generalization & Specialization

- Consider the entity types:
  - PERSON
  - STUDENT
  - GRADUATE STUDENT
- Every graduate student is a student
- Every student is a person

Notation for generalization/inheritence



Exercise

The Jonesburgh County Basketball Conference is an amateur basketball association for Jonesburgh county.
Each city in the county has one team that represents it.
Each team has a maximum of twelve players and a minimum of nine players.
Each tem also has up to three coaches (offensive, defensive, and PT coaches.)
Each team plays two games (home and visitor) against each of the other teams during the season.

Current technical issues

- Object-oriented databases
- Database connectivity
  - context interchange
- Managing data error
- Client-server database architectures
- Handling non-text objects
- Data warehousing/data mining
- Conversion from legacy systems

Current management issues

- Managing data as a resource
  - Who should own the data?
  - Who should enforce standards?
- Proliferation of on-line data
  - Responsible use of customer data?
- Access control and security

OPIM 210 - Management Information Systems - Fall 1998 -
Course Summary

"I think there is a world market for maybe five computers."
T. Watson, IBM, 1943

"There is no reason anyone would want a computer in their home."
K. Olson, Digital, 1977

"640K ought to be enough for anybody."
Bill Gates, 1981

"Businesses... have wasted billions of dollars believing the big lie of the Information Age. The lie says that if orgnizations had greater quantities of cheaper, faster and more useful information, they could increase their profitability and enhance their competitive positions..."
Michael Schrage in the *Harvard Business Review*, 1997

I. Technology

- A thorough understanding of the key technologies is important not only for managing IT, but for understanding the role of technology in competition now and in the future.

a. Basic technologies (general principles and specific technologies)
- Computer hardware
- Computer software (OS, languages, applications)
- Database technologies/transaction processing
- Networking (LANs, Intranets, Internet)
- Systems and the integration of components
  . Mainframes, client/server and the network PC (?)

b. Advanced technology concepts
- Communications: compression, network security, high speed networking
- Processors: CISC vs. RISC, supercomputing, caching
- Trends: Moore's law, Metcalfe's Law and their intersection
- Artificial Intelligence/Expert Systems

c. Applications of systems in specific settings
- Manufacturing: EDI, CIM, process controls (*Tiger Creek*), shop floor control systems
- Services: image processing, databases, workflow management (*USAA*) & groupware
- Decision support: EIS, DSS; strategic, tactical and operational (*Phillips 66*)
- Expert systems application (*Brooklyn DA*)

d. Where do systems come from?
- Systems analysis and design (theory)
  . Steps in systems analysis
  . Software engineering concepts
  . Methodologies: Waterfall, Information engineering, JAD, rapid prototyping
  . Tools: E-R diagrams, dataflow, CASE
- Pitfalls of software development (*Microsoft*)
- Insource vs. outsource; custom vs. package

II. Organization

• In order to effectively implement information systems you must understand and often change the way an organization functions

• You can apply economic rigor and structure to organizational analysis

a. Basic (intra-)organizational economics
- Centralization vs. Decentralization
- The "knowledge-based organization"
- Organizational architecture: decision rights, incentives, reward/punishment rules

b. Impact of information systems on the organization and vice-versa
- Changing role of skills and the structure of jobs (*Tiger Creek, Phillips 66*)
- Effective implementation of technology (*Phillips 66*)
- Impact of information and incentives on employees

c. IT enabled organizational change
- Business Process Redesign/Reenginering in theory
  . Steps to reengineering
  . Stories: Hallmark, Ford...
  . Role of IS in reengineering: enabler and driver
  . Differences between other important perspectives (e.g. TQM)
  . Importance of coordinated change - complementarities and the "matrix of change"
- The "failures" of reengineering
- Reengineering in practice: fixing incentives and information
- Better and worse ways to implement technology (*Tiger Creek vs. Phillips*)

d. Organizing to develop and operate information technology
- The organization of software development (*Microsoft*)
- The organization of the IS function (*CSC/GD*)
- Outsource vs. insource

III. Strategy

- IT is rarely strategic by itself, but can often be used to create or leverage strategic resources

- As IT changes the availability of information, many types of competitive advantage may disappear but new opportunities also emerge

a. Basic strategy
- Porter: five forces, generic strategies, value chain
- Competitive advantage: Price - Marginal Cost > 0
- Sustainable competitive advantage
  matters in a positive way, not too easy to imitatate, keep it up
- Economics of competition, price discrimination, search, externalities
- Difference between value creation and redistribution
- Magnifying glass theory: IS often not competitive by itself, but can increase the value of other advantages
- The limitations of IT "hustle": the red queen principle and competitive necessity
- Interorganizational economics: transactions costs, incomplete contracts
  . Drivers of transactions costs: uncertainty, asset specificity, infrequency
  . Results/Risks: Poaching, Shirking, Opportunistic Renegotiation
  . Sources of oursourcing value: scale, scope, specialization
  . Prevented by: ownership, contracting, monitoring
- Economics of information systems
  . Benefits: cost, quality, timeliness, service, variety
  . Valuing intangibles (reverse NPV)
  . Decisions with or without numbers
  . IT as an option
  . Risks: project, functionality, technical, financial, systemic

b. IT-enabled/related strategies in practice

- From competitive advantage to competitive necessity (*Baxter*)
    - . Resource based competitive advantage
    - . Problems of sustainability
- Signaling, Screening and Target Marketing (*Capital One*)
- Using information to beat up on your competitors (*Phillips; Cap One*)
  introduction to newly vulnerable markets
- Evaluating the relative risks of IS projects (*Microsoft*)
- Evaluating the risks and structuring the deal for IS outsourcing (*CSC/GD*)
- Managing partnership risks for a technology product (DVFS)

Competitive Analysis of IT Impact
OPIM 210 - Lecture 2

Il-Horn Hann

Some old views of IT Strategy

- Three types of systems
  - Strategic - leads to or maintains competitive advantage
  - Tactical - planning, information and management control
  - Operational- day to day operations (factory automation, transaction processing)
- Another Framework: McFarlan Strategic Grid

Strategic Impact of Existing Systems		Strategic Impact of Development Portfolio: L	H
	H	Factory	Strategic
	L	Support	Turnaround

The stock "success" stories of IT & competitive advantage

- American Airlines SABRE system
  - Progression of electronic markets
  - Advantage through network externalities
- American hospital supply ASAP
  - You be the judge
- McKesson Economost
  - Non-sustainable competitive advantage

Competitive Advantage

- Definition: Ability of a firm to earn supranormal profits (rents)
- Supranormal profits are revenues in excess of the user cost of all inputs
  - labor, materials, purchased services
  - user cost of capital assets
  - user costs on other types of intangible assets
    - Brand names, patents, ...
- Not necessarily related to accounting profits but should be reflected in stock price

Sustainable competitive advantage

- A factor or set of factors can lead to sustainable competitive advantage if:
  - Affects firm value in a positive way (advantage)
  - Not too many competitors can imitate it (competitive)
  - Can keep it up (sustainable)
- Which of these conditions usually holds for IT investments?

Some views of IT and strategy

- Capital cost as an entry barrier
  - "Nobody can possibly afford to match our investments in IS"
    - » Variant 1: First-mover advantage (unqualified)
  - When is this true? (What does it assume about the technology?)
- "Hustle" as a strategy
  - "We can make it better, stronger, faster..."
    - » Variant 1: "We just try harder"
    - » Variant 2: "Competitive advantage through operational efficiency"
  - What does this assume about your competitors?

Some views of IT and strategy con't

- The "Red Queen Principle"
  - Strategic Necessity
  - When is this OK?
    - Investment has negative NPV when evaluated on its own (against the base case of "things as they are now")
    - Not enough unmeasured or intangible benefit to make it positive NPV
    - ... but not doing it is even worse
  - What happens when the IS manager cries "competitive necessity" too often?

Thinking about strategy

- Generic strategies
  - TQM
  - Core competencies
  - Customer driven focus
  - Cost leadership
  - Differentiation
  - Market niche
- Specific elements/Sources of competitive advantage
  - Resource-based view of the firm
  - Network externalities
  - Product differentiation
  - Custoer differentiation
  - Search costs

Thinking about markets I: Perfect competition

- Large number of buyers and sellers
  - No actor has influence on price
- Homogenous product
  - Perfect substitutes
- Information efficiency
  - Full, uniform information about price and product
- Free entry
  - Zero economic profit

Examples: Most commodities (e.g. wheat, polyethylene)

IT and perfect competition

- Impact of cost lowering IT investment
  - Short run - lower cost firms can earn profits
  - Long run - all producers must match investments
  - What happens to firms that don't make the investment?
- All benefits passed on to consumers

IT is a competitive necessity, not a source of competitive advantage !

IT may drive markets toward perfect competition

- Homogenous product
  - IT allows products to be reverse engineered
  - Flexible manufacturing allows mass customization
- Information efficiency
  - IT can reduce search cost
  - Eliminates informational inefficiencies ("Big Bang at the LSE")
- Free entry
  - Lowers entry barriers by reducing scale economies
  - Shorten time to entry by allowing faster design

Thinking about markets II: Monopoly

- Characteristics
  - Single producer, multiple buyers
  - Unique product - no substitutes
  - Entry not possible
- Appears as a result of government regulation, ownership of critical inputs or technologies, anticompetitive behavior, scale effects
- Inefficient from a social standpoint
- Mainly an analytical device

Ways IT can be used by a monopolist

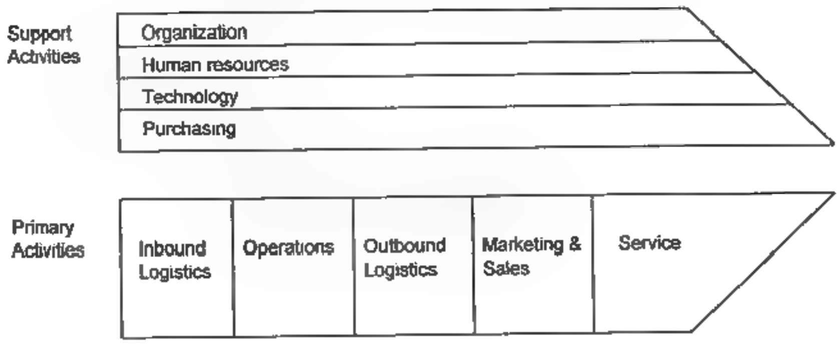
- Create a monopoly?
  - Unlikely, but possible (we'll talk about this later)
  - May be useful in maintaining monopoly
- Lower cost
  - Can increase profits and create consumer value
- Price discrimination
  - Charge as close as possible to willingness to pay of each consumer
  - Example: customer segmentation systems

Frameworks for talking about strategy

- Value Chain
- Five Forces
- Three Generic Strategies
- Extensions

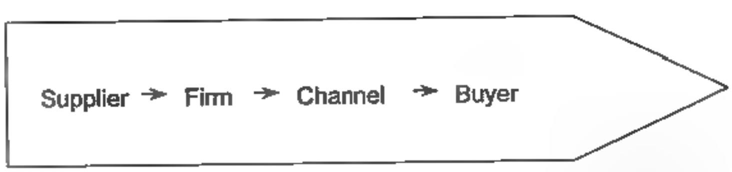
REMEMBER: These are tools to help you think through problems, not cookbook solutions. In addition, there are numerous other context-specific frameworks.

Value Chain - Activities



From: Porter & Miller, 1985

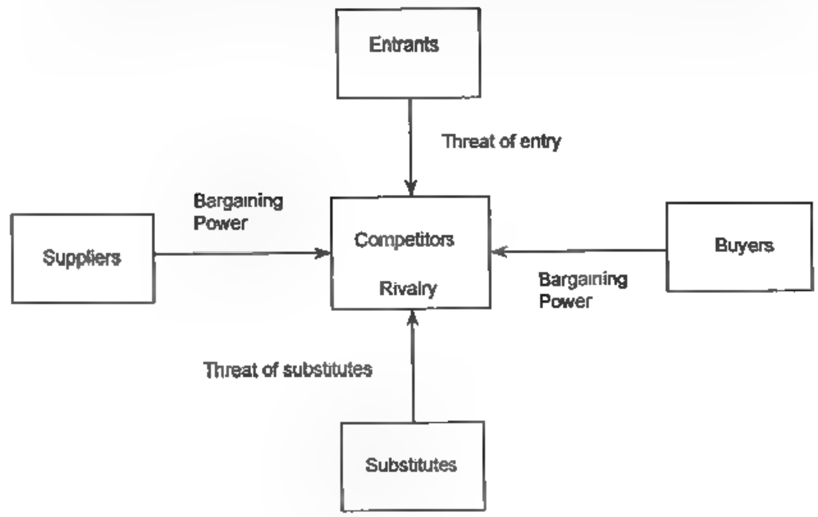
Value Chain - System



From: Porter & Miller, 1985

- Identify where value is created outside the firm
  - Can a firm use IT to appropriate this value?
  - Are there additional opportunities to create gains from trade?

Five competitive forces (Porter, 1980)



Some possible IT influence on five forces

- Create entry barriers
  - Network externalities (proprietary IOS)
  - Build switching costs into buyers/suppliers
  - Use systems to leverage unique assets
- Reallocate bargaining power
  - Reduce supplier search cost/price uncertainty
  - Understand consumer preferences
  - Selectively provide information to consumers
- Reduce rivalry
  - Differentiate products

Three generic strategies

Strategic Advantage

Strategic Target		Uniqueness	Low cost position
	Industry	Differentiation	Overall Cost Leadership
	Segment Only	Focus	

- Porter (1980)

Why only 3 strategies?

Summary

- Need to understand competitive dynamics of the industry
- Use the basic frameworks to help you think about competition
  - What type of competition do you face?
  - What types of market inefficiencies are exploitable?
  - If you assume that a system is strategic, it probably isn't
- What makes a strategic system may be very different in different industries

Competitive advantage due to market imperfections

- Huge literature on various types of market imperfections
- Will focus here on several that are relevant for IT investments
  - Resource-based competitive advantage
  - Search costs
  - Product differentiation
  - Customer differentiation
  - Network externalities
- An understanding of (some of) these may prove useful for your case assignment

35

Competitive Analysis of IT Impact
OPIM 210 - Lecture 3

Il-Horn Hann

Frameworks for talking about strategy

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- Five Forces
- Three Generic Strategies
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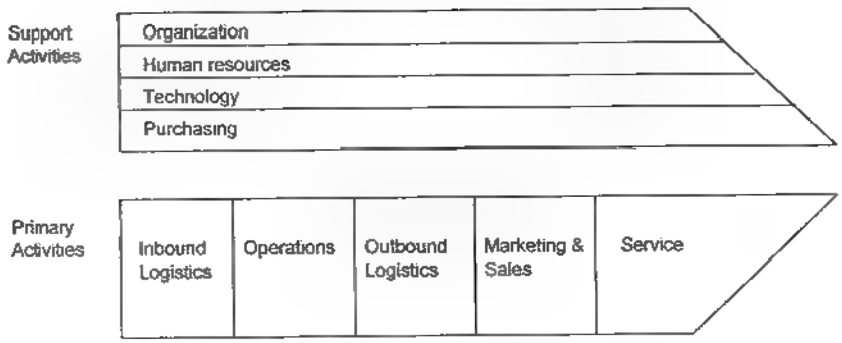

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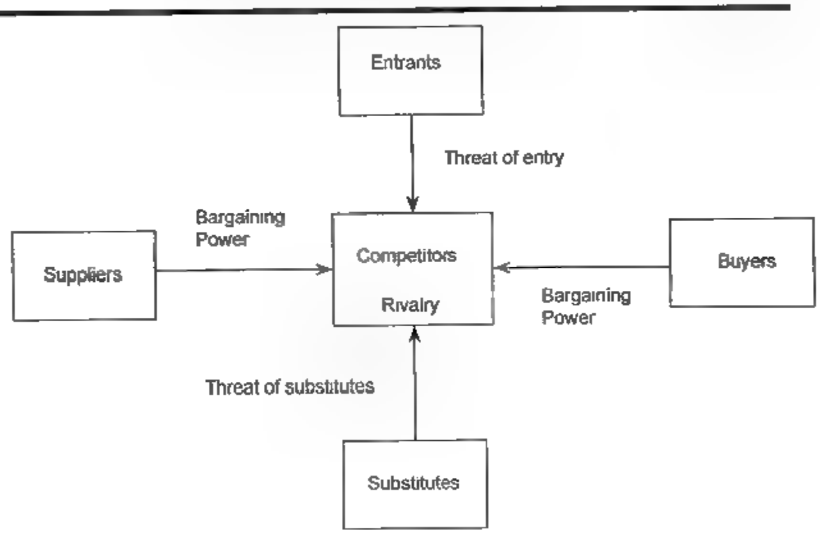

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  - (6) Selectively provide information to consumers
- Reduce rivalry
  - (7) Differentiate products

Three generic strategies

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Strategic Target	Industry	Differentiation	Overall Cost Leadership
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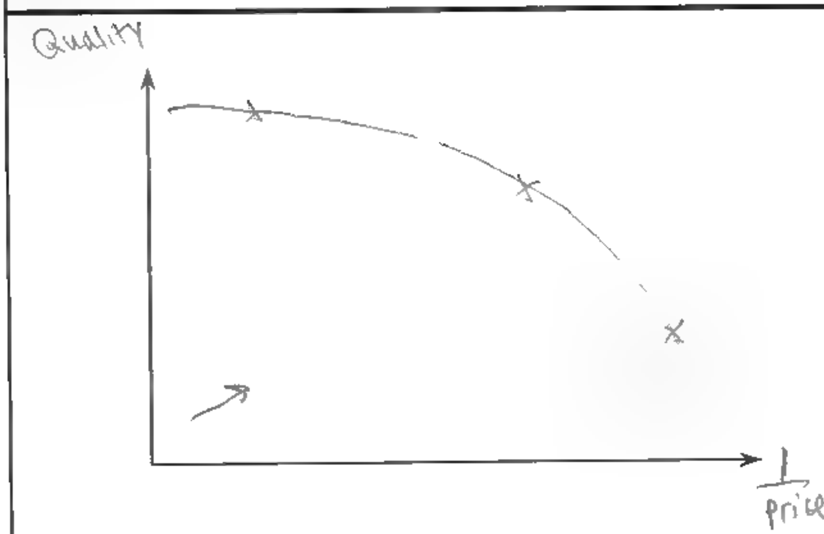

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Resource-based competitive advantage

- Idea: "Ownership" of one critical item makes an overall strategy hard to replicate
- Sometimes IT can be used to create a unique resource
  - Rosenbluth travel getting huge market share in Philadelphia from "IT"
  - Sometimes the resource is an installed base of users (switching costs, sunk investments or network externalities)
- More likely: A magnifying glass theory
  - IT rarely creates competitive advantage on its own
  - However, IT is very good at magnifying existing advantages
  - Ex.: BZW

A Framework

Appropriability of idea / IT ← PC Makers

Factor Market	tight	weak
imperfect	$ → firm ↓ Supplier	$ → Supplier
competitive	$ ↓ firm	$ → Consumer

MSFT Intel → Factor Market

Search Costs

- Idea: Price charged by producer is not the cost faced by the consumer because finding products and/or prices is costly
- Search costs:
  - travel
  - opportunity cost (time)
  - losses because cannot identify lowest price
- Search costs hurt consumers in two ways
  - Direct increase in purchasing cost (pure waste)
  - Allows producers to earn rents (increase prices)
- Social loss
  - Some people who would buy don't

6

Search and strategic IT

- IT lowers search cost
  - Intensifies price competition
  - "Winner take all" markets
  - Shifts competition onto other dimensions
- Strategic use of search cost (Bakos)
  - Want customers to find your product (product search)
  - Don't want them to easily compare price unless you are low cost (price search)
  - In practice
    - » Why don't many web sites have price information?
    - » What has happened to price search agents?
    - » How much of this has or is going to happen on the net?

Product Differentiation

- Idea: when products are not all the same and customers have heterogenous preferences, firms can have market power over a small group
- Many possible dimensions to differentiate products
  - Time
  - Intangible attributes: service, quality
  - Physical attributes: color, size, ...
- Examples: clothes, airline tickets
- Note: Two types of differentiation
  - Vertical - build a better product (Yugo vs. Mercedes)
  - Horizontal - position yourself in "product space" away from your competitors (red and blue cars)

Differentiation alone is not sufficient

- If all producers have free entry into every segment, no competitive advantage
- Factors that augment differentiation
  - Standards - ex post switching costs for ex ante identical products
  - Search cost - can enhance effects of differentiation when products are not comparable
  - Limited number of competitors - firms locate away from each other
    - » Example: airlines
  - Careful targeting plus small market inefficiencies can create profitable niches

IT and differentiation

- IT allows production to be more flexible
  - Allows customer needs to be better satisfied (good)
  - Allows producers to extract some of this value (neutral to bad)
  - Differentiation may reduce rivalry between firms
- Allows customer needs to be better identified
  - Micro-segmentation (generally good)
- An example of the options value of IT: May allow you to meet specialized customer needs in the future

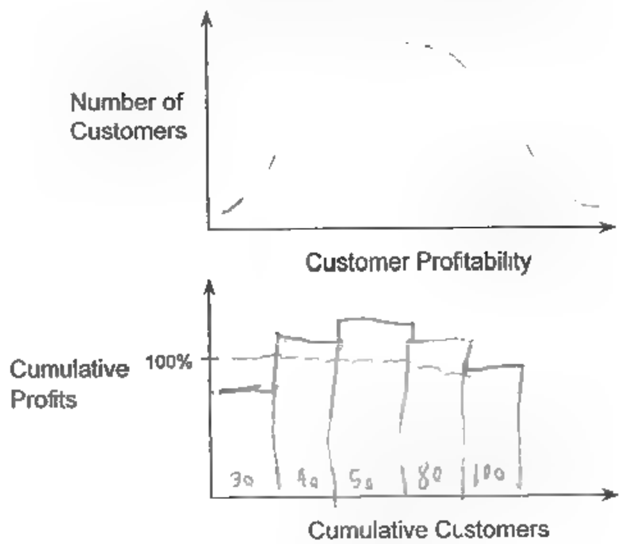
Customer differentiation: Price Discrimination

- Third degree
  - Price each group of customers differently based on observed characteristics
  - Examples: student discounts, discounts to WWW users
- Second degree
  - Offer different price-product bundles that are attractive to the "right" customers but not others
  - Examples: student versions of software
- First degree
  - Figure out each persons willingness to pay and charge them that price
  - Examples?

Customer differentiation: IT and Target Marketing

- Idea: know your customers
  - Not all customers are equally profitable
  - Not all firms know the profitability of their customers
  - Even if they did know, not all firms can act on it
    - » Service commitments
    - » Regulation
    - » "Falling in love with a strategy"
- Creates an enormous opportunity for a flexible, informed entrant
  - Signet Bank story
- Simplistic responses can wipe out competitors
  - Average cost pricing is often the culprit
- The market for lemons (Akerlof)

Profit Distributions and Skew Curves



Network externalities

- Idea: in some products, the value of adoption increases with the number of existing users
- Gives advantages to producers whose product is adopted first
- Example: internet browsers, spreadsheets
- Many IT related products show these effects
  - airline reservation systems
  - operating systems
  - software
  - videophones/videoconferencing
- What is your strategy here?

Summary

- Need to understand competitive dynamics of the industry
- Use the basic frameworks to help you think about competition
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  - What types of market inefficiencies are exploitable?
  - If you assume that a system is strategic, it probably isn't
- What makes a strategic system may be very different in different industries

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10/9 - project proposal
11/2 - Final proposal
12/7,? - presentations
12/9 - written report

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Hardware
OPIM 210 - Lecture 6

Il-Horn Hann

Bits and Bytes

- Computers do all computation using the binary number system (0, 1)
  - Counting order: 0, 1, 10, 11, 100, 101, 110, 111
  - Programmers and hardware designers also use hexadecimal, which assigns a number to each combination of 4 binary digits

0000 = 0	0101 = 5	1010 = A	1111 = F
0001 = 1	0110 = 6	1011 = B	
0010 = 2	0111 = 7	1100 = C	
0011 = 3	1000 = 8	1101 = D	
0100 = 4	1001 = 9	1110 = E	

Good for handling large numbers: 65520 = FFF0H = 1111111111110000

Bits and Bytes

- Letters and symbols are usually represented by 8 binary digits (a byte)
  - Two systems: ASCII (common), EBCDIC
  - Example (ascii): letter Z = 90 decimal = 5AH = 01011010
  - Note: hexadecimal usually has an H at the end. Binary and decimal are usually assumed from context
    - » Don't confuse ascii characters and numbers:
    - » The ascii number 1 is 49 decimal or 31H
- Numbers are either represented directly (integers) or using a floating point format

Some common sizes of things

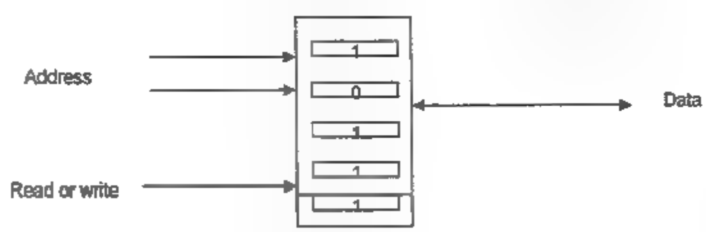
- Modern microprocessors typically can handle single numbers either 32 or 64 bits long
- Computer file sizes are usually measured in kilobytes (1 K = 1024 bytes)
- Memory is sold in megabytes (1MB = 1048576 bytes)
- Hard drives hold 500 MB to ~8 Gigabytes (GB - 1024 MB)
- Easy way to remember:
  - Kilo: 2^{10}
  - Mega: 2^{20}
  - Giga: 2^{30}

Why Binary?

- Old days: Analog (ex. old/local phone lines)
  - Complex fabrication process
  - Never really accurate (noise, attenuation)
  - Hardware highly specialized

- Modern: Digital (ex. new long distance lines)
  - Virtually error free (especially with error correction)
  - Easy conversion back to analog
  - Can use simple building blocks to build circuits
  - Allows construction of general purpose computers
  - Binary is the simplest digital representation

Components - Memory



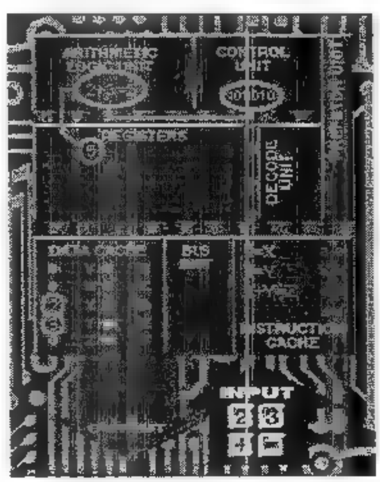
A 4-bit Memory with parity

- Types of memory
  - DRAM - Dynamic Random Access Memory
  - SRAM - Static Random Access Memory
  - ROM - Read only memory
  - EPROM/EEPROM - Programmable Read Only Memory

Memory Comparison

	DRAM	SRAM	ROM/EEPROM
Name	Dynamic Random Access Memory	Static Random Access Memory	Read Only Memory/ Electrically Eraseable Programmable ROM
Size/chip	Large up to 32Mb	Smaller up to ~1Mb	Smaller 64K-256K
Speed	50-80 ns	12-25 ns	varies but slow (often >100 ns)
Volatility	Volatile (needs refresh)	Volatile (needs power)	Non-Volatile
Price	Inexpensive ($5 MB or less)	Moderate ($20-250/MB)	Depends
Applications	Main memory Video memory	Cache memory High performance High-end video (VRAM)	Start-up programs Settings Mass Storage (EE)
Comes in	30/72 Pin SIMM DIMMs, others	Chips	Chips Cards
Special flavors	EDO, SDRAM Dual Port		Flash

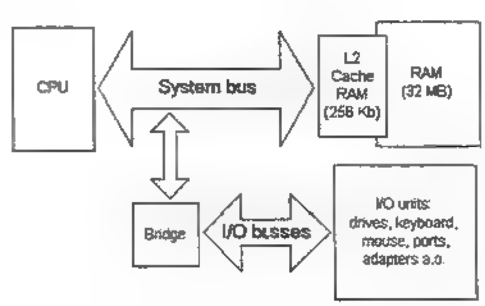
How microprocessors work



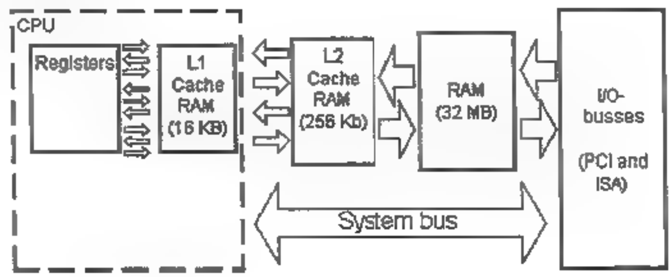
What determines processor speed?

- Fabrication technology
- Clock speed
- System bus width (8-64 bits)
- Caching (internal and external)
- Ability to execute instructions in parallel
  - Intelligent caching/pipelining
  - Branch prediction
- Specialty processors (FPU)
- Instruction set complexity

PC busses



Cache RAM



Performance considerations

- Speed of data path between fast devices
  - High speed local bus for disks and video
- Specialized processors to balance workload
  - Math coprocessors for FP/Matrix operations
  - DMA controllers for block data transfer
- Exploit speed hierarchy of memory

Fast ← Slow

Internal Cache External Cache Main Memory Mass Storage

Frequently Used ← Infrequently Used

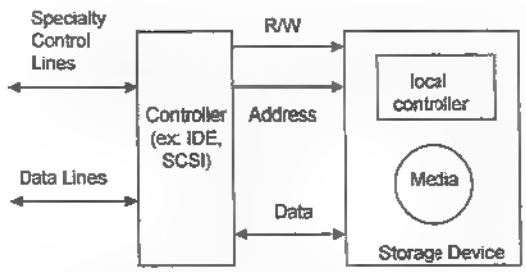
The endless debate: CISC vs. RISC

- CISC (Complex Instruction Set Computing)
  - Many instructions (can be >100), variable length, variable execution time
  - Advantage: flexibility, easier programming
  - Disadvantage: complex to build, overhead to handle flexibility
  - Examples: Pentium, Motorola 680x0 family, Intel 80x86/Pentium
- RISC (Reduced Instruction Set Computing)
  - Limited set of instructions, same length, same execution time
  - Advantage: simpler design, faster clock speed, can be parallel
  - Disadvantage: increased complexity in programming
  - Examples: PowerPC 604, DEC Alpha

Which is faster?... it depends

- Software optimization is different
  - CISC software can run much slower if RISC processor needs to emulate instructions (ex: early PowerPC)
  - Optimized RISC code car be more efficient
  - Most software is optimized for CISC
- RISC is generally better for narrow applications
  - Video, matrix processing, printers, engineering workstations
- Clever design tricks have kept CISC ahead
  - Pipelining, parallel processing
- Ultimate winner: ? ... maybe hybrids

Mass storage



- Relatively slow, high capacity storage
- Major examples: hard disk, floppy disk, tape, CD-ROM
- Others: Optical, Magneto-Optical, Semiconductor
- Historical: paper tape, punch cards, cassette tape

Mass Storage Options

	Hard Disks	Floppy Disks	Tape	CD-ROM
Types	Fixed Disk Packs	Sizes	Cartridges Reel	Recordable Non-recordable
Speed	Fast >5 MB/sec.	Slow ~1 MB/min.	varies alot several MB/min.	Intermediate 200KB-1.5MB/s
Access	Random	Random	Sequential	Random
Removable	Not usually	Yes	Yes	Yes
Capacity	100MB - 16GB	700K - 3MB	limited by length often ~500MB	~600MB
Price - Drive	$50/GB	$30-50	Varies $200- >10K	Std: $100-$500 Record: $.5-1K
Price - Media	n/a	$.25/MB	varies, often <$.1/MB	$1/disk record. $<1/disk mfg.
Applications	Primary mass storage	Backup/transport Software dist.	Backup Archiving	Archival Software/MM dist.
Reliability	Long can be damaged	Shorter easily damaged	Reliable if handled properly	Very reliable

Mass storage issues

- Speed determined by multiple factors
  - Channel speed (IDE vs. SCSI)
  - Bus Speed (ex. ISA, EISA, PCI, VL)
  - Seek time (latency, interleave, track-to-track time)
  - Software drivers
- Trend: high capacity removable systems
  - Zip and Jaz Drives
  - Non-volatile silicon devices gaining popularity

Output devices - Video

- Video
  - Monitors: interlaced vs. non-interlaced, dot pitch, scan frequency
  - Flat panel: active vs. passive matrix, size
  - Video accelerator cards: memory, processor, compression (MPEG), software drivers, data transfer rate
- Trends
  - Intelligent controller cards
  - Large, flat monitors
  - Large semiconductor screens (14" Active Matrix)

Video - Compression

- Video images take enormous amounts of space
  - single 1024 x 768 image in full (24 bit) color = 2MB
  - refresh rate at 30 Hz = 60 MB/second
- Different compression strategies
  - Video: MPEG - skip frames and interpolate
  - Still: JPEG - trade size and quality
  - Most video/audio based on lossy compression
- Hardware compression often faster/better
  - May be only way to do real-time compression
  - Compression algorithms still developing

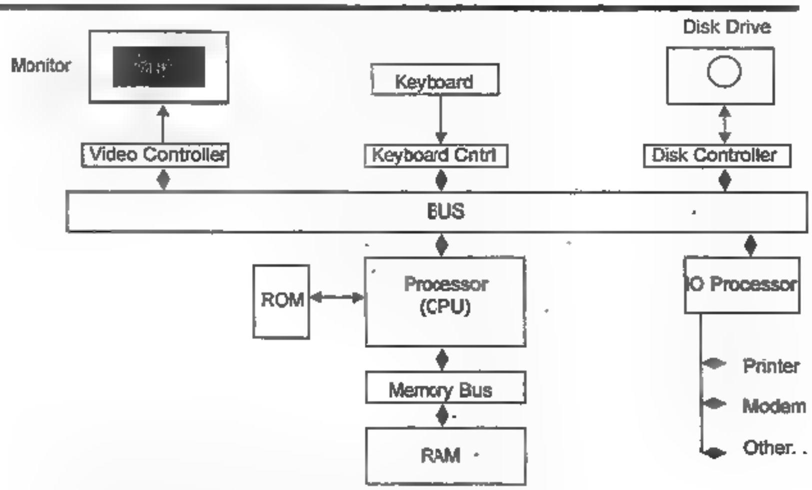
Output Devices - Printers

- Dot matrix
  - Inexpensive but moderate print quality
  - Can be extremely fast
  - Color not remarkably more expensive then BW
- Ink Jet
  - Inexpensive, better print quality, low-cost color
  - Trend toward increasing sophistication and speed
- Laser
  - High quality (600 dpi common), can be fast (20ppm)
  - Color is still expensive but price is falling

Input devices

- Keyboard
- Mouse
- Pen
- Joystick/Game pads
- Digital camera
- Digital audio
  - Voice recognition
- Scanners
- Speciality devices

Putting the parts together: Systems



- Simple PC (typical around 1990)

Device Interconnections

- System buses
  - ISA (Industry Standard Architecture): 8Mhz x 16 bit
  - PCI: 33 Mhz x 32 bit
  - Others: VL, NuBus, Microchannel (MCA), EISA
- Specialty buses
  - AGP: Accelerated Graphics Port (video to memory)
  - Memory buses
- External
  - SCSI
  - USB (keyboards, mice)

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Communications Technology

Il-Horn Hann

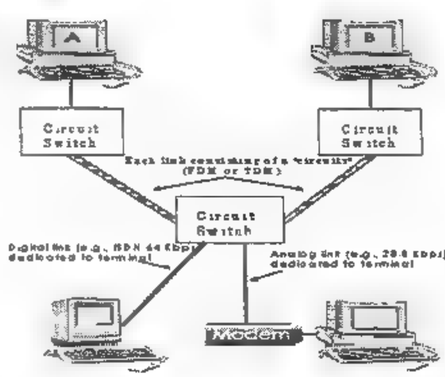
Outline

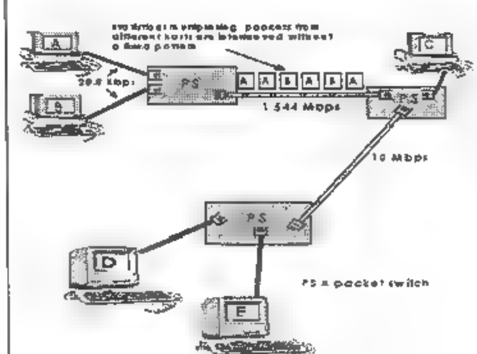
- Communication basics
- Introduction to Local Area Networking (LAN)
- Introduction to Wide Area Networking
- The internet
  - ... as a wide area network
  - encryption and network security
  - features and services
- Other topics as time permits
  - hacking... and why you should care about network security
  - internet to the home
  - others?

Communication Basics

- Analog vs. Digital
  - Conversions
- Protocols (rules for using the channel): TCP/IP, UDP...
- Communication direction: simplex, half-duplex, full-duplex
- Timing: Synchronous vs. Asynchronous
- Switching: channel, message, packet
- Channel type: cable/fiber/wireless & public/private

Telecommunication networks: Circuit vs packet switching





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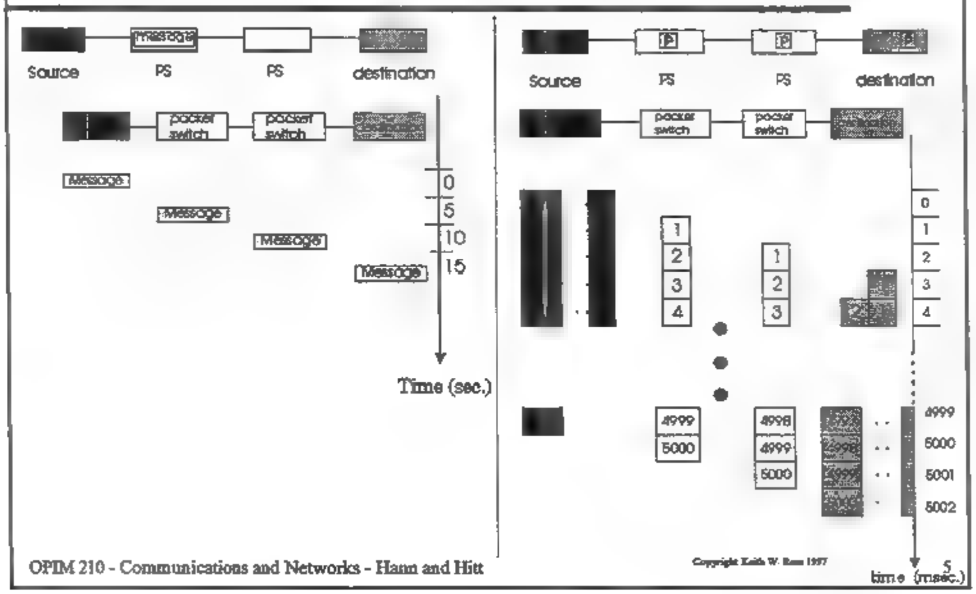
type of
packetswitching

3x's faster

Message vs. packet switching



Connectionless vs. connection-oriented services

- Connection-Oriented Service (e.g., TCP)
  - Acknowledgements
  - Flow Control
  - Congestion Control
- Connectionless Service (UDP)
  - No Acknowledgements
  - No Flow Control
  - No Congestion Control

ISO Architecture (standard)

- 7 Layers
  - Application (7): how programs use services
  - Presentation (6): syntax/format of transmission
  - Session (5): setup and terminate data streams
  - Transport (4): make sure data gets there
  - Network (3): how paths are established
  - Data link (2): how devices use the network
  - Physical (1): electrical and physical connection

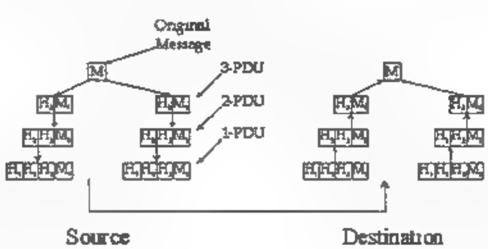
Uppper layers

Lower layers

Internet Protocol

Application L.: Provides services to user
Transport L.: Segment mess. to packets
Network L.:Routing packets from source to dest.
Data Link: Moves packet from node to node
Physical L.:provides physical medium

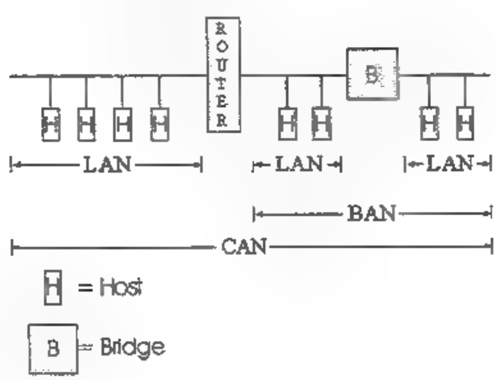
	Stack		PDUs
Layer 5	Application	software	
Layer 4	Transport	software	segment
Layer 3	Network	software	datagram
Layer 2	Data Link	hardware	frame
Layer 1	Physical	hardware	packet



Local Area Networks (LANs)

- Connects computer together at a location (local)
- Dominant network topologies
  - Bus
  - Ring (e.g. Token ring)
  - Hub
- Hardware
  - Network interface cards for computers
  - Cabling (UTP, coaxial)
  - Gateways, hubs, repeaters
  - Servers (print, file, communication)
- Network operating system (NT Server, Novell NetWare)

LAN, BAN, and CAN



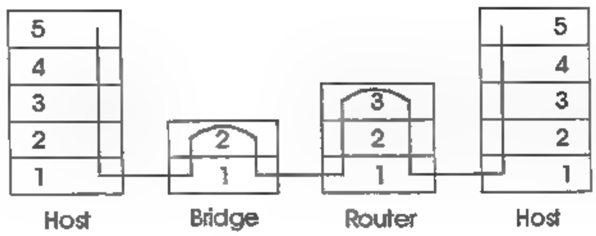
Why build LANs?

- Share peripherals
- Access to data
- Multiuser software
- Connect to other networks
- Migrate from mainframes to client-server

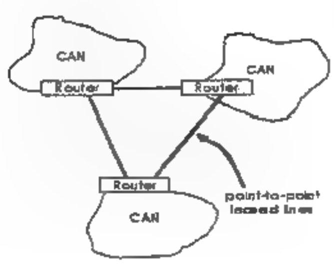
The move to client server

- Advantages
  - Smoother growth
  - Effective use of resources (computing power, shared devices)
  - Cut transmission costs
  - Faster
- Disadvantages
  - Administration
  - Security
  - Data integrity
  - Standardization

Bridges and Routers



WAN

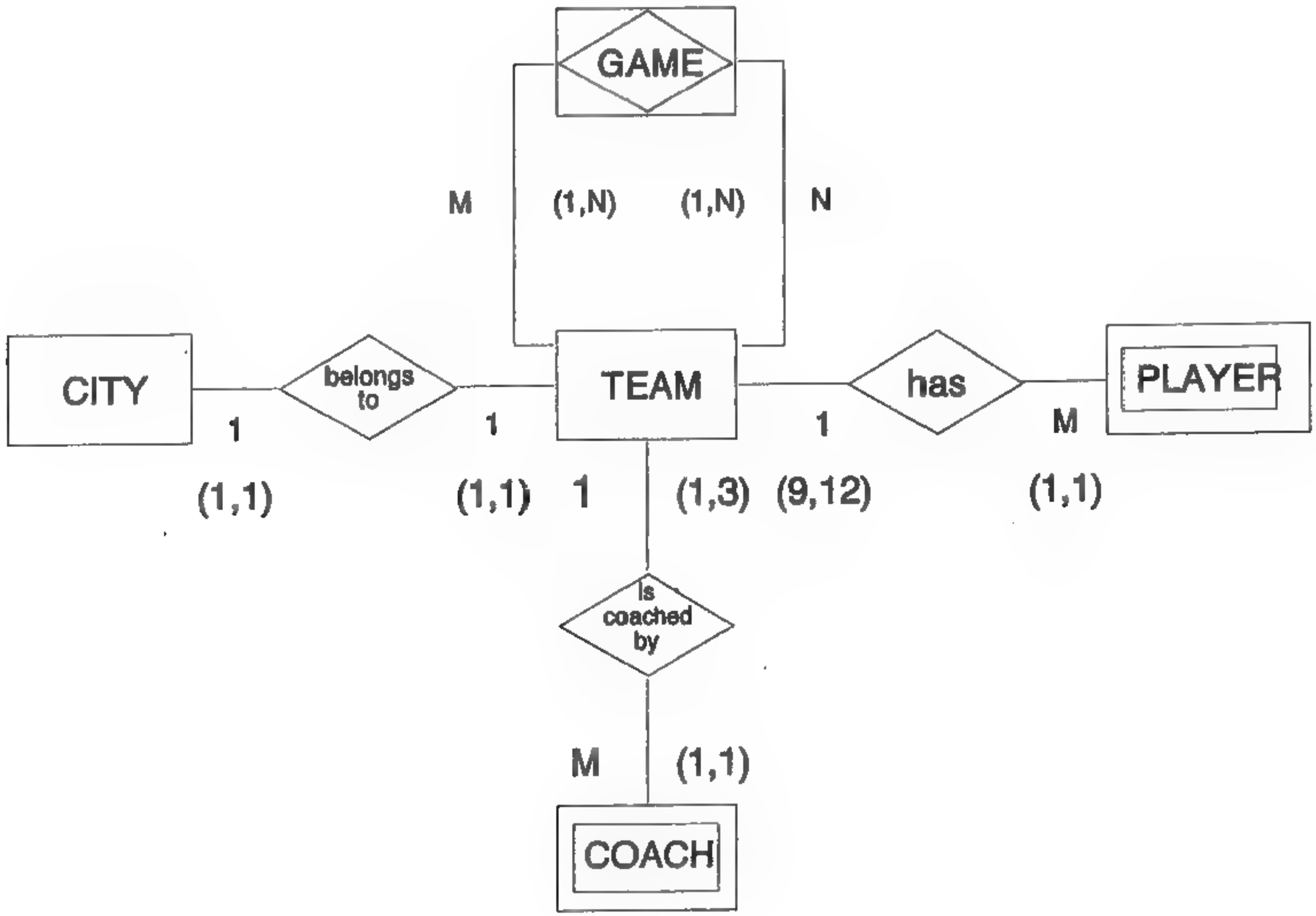


The Internet... Technology

- What is the technology behind the internet?
  - A data network
    - High volume lines (backbone) between routers (NAPs)
    - Regional networks by common carriers and others
    - Access resellers (UUnet, AOL)
  - A packet switching communications protocol (TCP/IP)
  - A naming and addressing convention
    - IP, and Domain Naming Services (DNS)
  - A set of communications "services"
    - FTP, HTTP, Gopher, Telnet...

A few important facts

- Large and growing rapidly
  - Number of users doubles (or more) each year
  - In 1995, over 120,000 domains
  - Estimated 50+ million users
- Now open for business
  - Conversion from public to private in 1995
  - However, commercial content not socially welcome everywhere
- No "owner"
  - A semi-formal set of standards and access agreements with some government support


GAME
M
(1,N)
(1,N)
N
CITY
belongs to
TEAM
has
PLAYER
1
1
1
M
(1,1)
(1,1)
1
(1,3)
(9,12)
(1,1)
is coached by
M
(1,1)
COACH

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Expert Systems/Artificial Intelligence

Il-Horn Hann

What is AI?

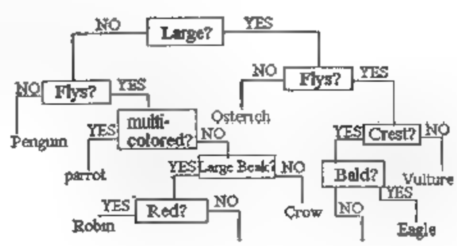
- Artificial Intelligence
  - Characteristics of human intelligence
  - No self-awareness
- Brief history overview:
  - Term coined in 1956 in Dartmouth by John McCarthy
  - Early development: Feedback mechanism and logic theory
  - Died out, but has recently staged come back

What is AI?

- Disciplines:
  - Expert systems/Neural networks/Genetic Algorithms
  - Natural languages/Human sensory capabilities/Robotics
- Issues
  - How do you know what its reasoning process is?
  - Dealing with environmental change
  - Data required to get stable behavior

Expert System

- What is it?
  - Knowledge base, inference engine, UI
  - Mimics the expert
  - If-then rules
  - Top-down approach
- Characteristics
  - Solve problems
  - Understand information
  - Can learn



Expert Systems

- Examples
  - Campbell's Soup: Giant cookers
  - Banking: Loan application, Stock pricing
  - Others:
    - Analysis: Medical, oil exploration, bank loan
    - Repair: Automobile, computer, satellite

Natural Language Systems

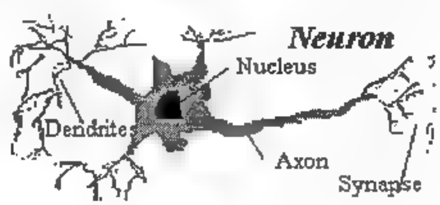
- Accept, interpret, and execute instructions
- Goal: natural interaction between computer and user
- Examples:
  - Database query: "Let me see the average salaries by job description in the marketing department"
  - Conversation systems

Human Sensory Simulation

- Seeing, hearing, speaking, and touching
- Examples:
  - Voice recognition
    - complex task
    - IBM's voice system, credit card numbers, etc.
  - Vision input systems
    - assembly line inspection robots
  - Character recognition
    - Apple's Newton

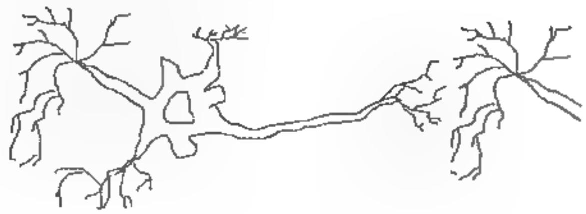
Neural Networks

- Parallel: Human brain
  - Neurons, dendrites, synapse
  - Firing signals, basis for processing binary numbers
  - trillions of neurons in the human brain

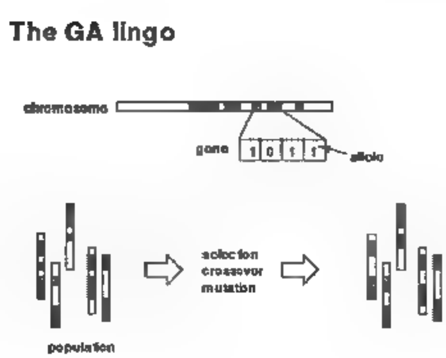


Neural Networks

- How they work
  - Bottom-up approach
  - Input layer, output layer
  - feed-forward networks
  - backward propagation



Genetic Algorithms



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Communications Technology II

Il-Horn Hann

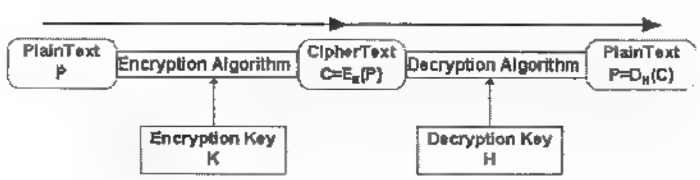
Internet Security

- Security:
  - Secrecy
  - Authentication
  - Nonrepudiation
  - Data integrity
- Security approaches
  - Passwords
  - Cryptography
  - Firewalls
  - Secure protocols

Internet Commerce Paradigms

- E-mail verification
- Commerce server
- SET protocol
- Digital cash

Elements of Cryptography



Symmetric Key Algorithm

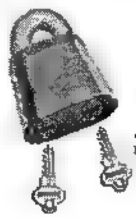
H=K

Same key for encrypting and decrypting

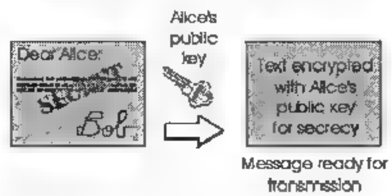
2

Public key algorithms

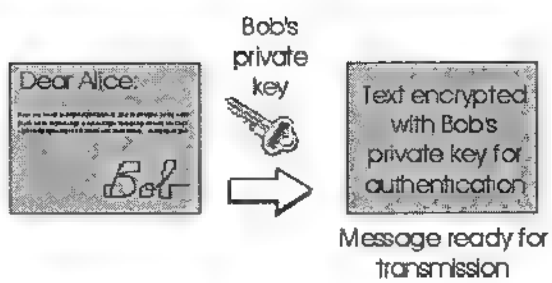
Public Key



$$P = D_H(E_K(P)) = D_K(E_H(P))$$

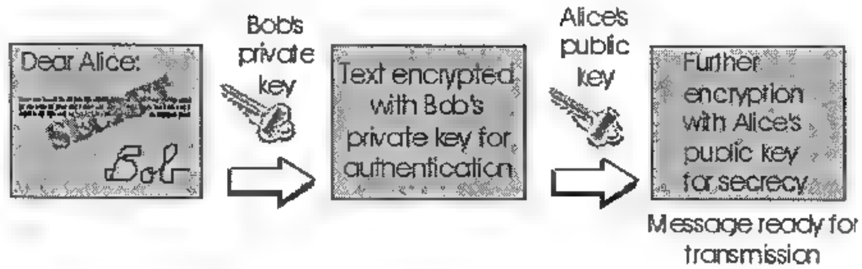


Digital Signature



When Bob encrypts his message with his private key, we say that Bob has *digitally signed* the message.

Secrecy and Authentication



Public and symmetric key

- Public Key
  - » Users establish a public key, available to others, that can encrypt messages that can only be decoded with a private key held by user
  - » Main issue: trusting the server that provides public keys
  - » Can be used to create digital signatures
  - » Most common: RSA
- Symmmetric Key
  - » Parties establish a key in advance
  - » Main issue: need to know with whom you will communicate in advance
  - » Most common: DES

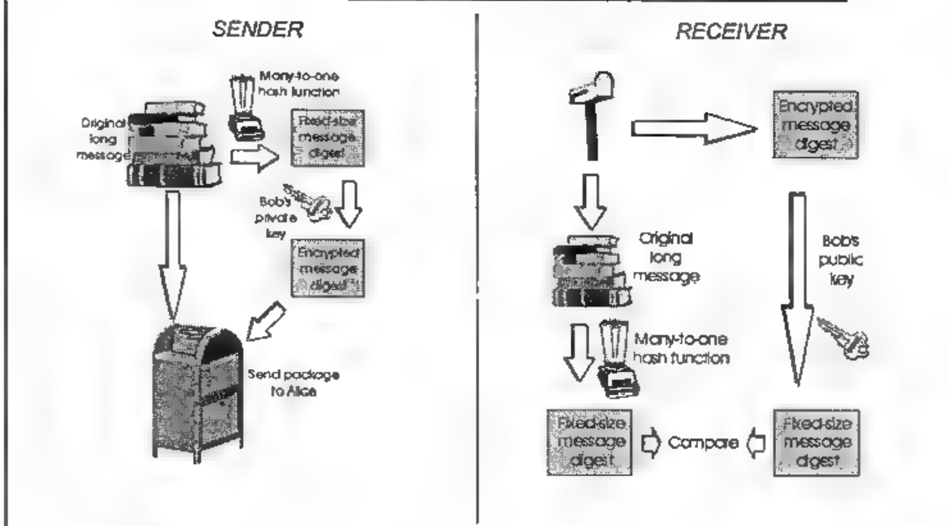
Public Keys

- Each person has a pair of keys for H encryption and K for decryption
- Make H publicly available
- Alice uses Bob's H to send him a private message $E_H(P)$
- Bob decrypts with K
  - $P = D_K(E_H(P)) = D_H(E_K(P))$
  - No one else knows K
- Works as long as
  - K is really kept secret
  - Hard to compute K from H
  - Get the correct H from some trusted source

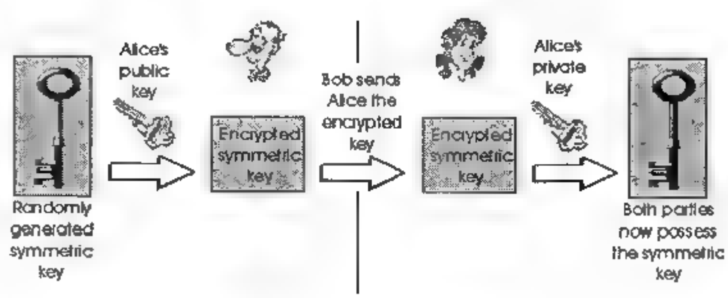
Message Digests

- Properties of the hash function
  - 1.It is impossible to recover the original message from the message digest.
  - 2.If the hash function is applied to two different messages, then the resulting message digests are different with very high probability..

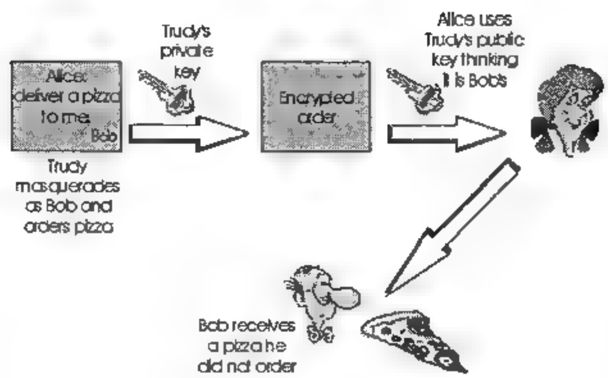
Message Digests: how it works



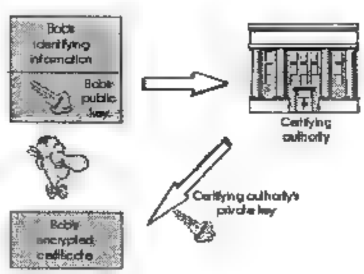
Session Keys

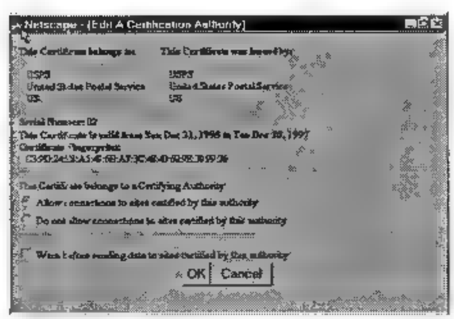


Certificates

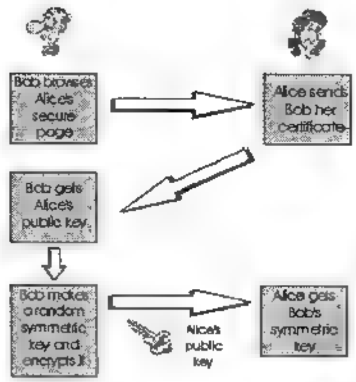


Certificates con't





How the Commerce Server Works



SSL (Secure Sockets Layer)

How it Works:

1) Bob clicks on a link that takes him to a secure page.

2) The Server sends to Bob its certificate for this page which includes the server's public-key. This certificate has been encrypted with the Certifying Authority's private-key. (Actually, message digests are used.)

3) The Client (Bob's machine) decrypts the Server's certificate using the Certifying Authority's public-key, which has been downloaded previously on a certificate of its own. The Client then sends the Server a session key. Before sending the session key, the Client encrypts it with the Server's public-key.

4) The Server decrypts the session key. All further correspondence between the client and server is encrypted with the session key.

Public Key Algorithm: Diffie-Hellman Key Agreement

- Agree on a shared, private key with insecure communication
  - Alice and Bob each choose a (private, public) pair of values independently
  - Each sends the public value to other
  - Construct shared key from own private value + other's public value
  - Can't construct shared key from the two public values

This segment of the presentation courtesy of Chris Dellarocas at MIT

Arithmetic Preliminaries

- x mod p = remainder after dividing x/p
  - 29 mod 13 = ??

$$g^x g^y = g^{x+y}$$

$$g^{xy} = (g^x)^y = (g^y)^x$$

given g, x, and p

- easy to compute $g^x \bmod p$ given g, x, and p
- (very) hard to compute x such that $y = g^x \bmod p$
- Called discrete log problem

Diffie-Hellman Key Creation

- Large prime p, integer g<p are public knowledge
- Alice picks a secret number a
  - send $X = g^a \bmod p$ over insecure channel to B
- Bob picks a secret number b
  - sends $Y = g^b \bmod p$ over insecure channel to A
- Shared secret key is $g^{a*b} \bmod p$
  - Alice and Bob can both compute it
  - Darth can't compute it from just g^a and g^b

A few comments on cryptography

- Probably technically secure
  - » Most cryptography systems rest on the assumption that certain mathematical operations are "hard"
  - » Breaking a system that does not change keys is only a question of time
- ... but cannot control the human element
- May be illegal in some countries
  - Governments generally restrict quality of cryptography available

Security: Firewalls

- A technological barrier that isolates an internal network from the outside world
- Some types of firewalls
  - Screening routers - choose which packets to pass
  - Bastion hosts
    - » Internal net does all outside communications with this server (called a *proxy server*)
    - » External requests are all passed to this server
    - » May be protected by another screening router
    - » Generally this server is stripped of all software except security software and required services
- This is a complex technology (up to 200K/host)

Client-Server Security: Kerberos

- Idea: never send passwords across a network (even encrypted)
  - Make a physical connection (sneakernet) to establish a password for use between client and server
  - Server sends client an encrypted message that includes a session key and a stub (maybe multiple)
  - Client can decrypt the session key and stub with password
  - Stub and request sent to file server using session key
  - Server decrypts message; checks stub for authentication
  - Can get multiple tickets at once (don't need to keep password in memory)
  - Tickets expire (time<< time to crack encryption)

World-Wide Web

- A client server architecture using a standard set of protocols
  - Servers running special software that house and deliver data and run programs
  - A Web Browser (client)
  - A set of protocols and languages
    - » HTTP - hypertext transfer protocol
    - » HTML - hypertext markup language
    - » emerging standards for JAVA/Active X
  - Also integrates other internet services (e.g. FTP)
    - » Unusual feature: when HTTP connection established, server is informed of what types of services/formats the client can handle

Interesting Internet/Web Technologies

- Real-time Audio, Video
- Teleconference and internet phone
- Virtual reality and animation
- Electronic cash
- Search engines and information retrieval
- Emerging electronic markets
- Traffic profiling and analysis
- Others?

Information Systems Outsourcing

OPIM 210 - Fall 1998

1

What is outsourcing?

- **Outsourcing**
  - Using an outside vendor to perform an activity that would normally be conducted in-house using your own staff
- **Why do people outsource?**
  - Vendor advantages
  - Better use of scarce resources
  - Internal disadvantages
  - Financial concerns
- **Forms**
  - Total outsourcing: Take my IS shop...
  - Project-oriented: Build me a system
  - Process outsourcing: Do my payroll, manage my inventory
  - "Body Shop": I need five IS people for a month

2

Link to managment theory

"Core competencies"

- Do only things you are advantaged at
- Trade with others to get complementary inputs

"Resource-based competition"

- Defensive measure
- Get par with your competitors

A simplistic (but partially correct) view...

- Vendors are wonderful
  - Economies of scale: bigger is cheaper
    - operating equipment (networks, mainframes)
    - investment in new technologies
  - Economies of specialization: narrower is cheaper
    - better management
    - better staff and career development
  - Economies of scope: combining is cheaper
- Vendors are evil
  - "The are not your partner because you don't share the profit motive"
  - "How can they possibly be cheaper if they use my staff and my facilities... there must be hidden pitfalls"

Economists perspective on outsourcing

- A tradeoff
  - Efficiency gains from using the "best" provider
  - Transaction costs of going outside the firm
    - Arises due to "bounded rationality"
- Transactions costs
  - Explicit costs: searching, writing contracts, monitoring, enforcing...
  - Implicit Costs: Transaction Risks
    - Poaching - theft of resources in a way that damages owner
    - Shirking - deliberate underperfomance on activities difficult to measure and claiming full payment
    - Opportunistic renegotiation - when an unexpected event makes two parties less than equally committed to a continued relationship, the party that is less committed can extract more value
  - Cost Drivers: Uncertainty, infrequency, asset specificity

Ways of minimizing transaction risks

- Governance Structure (Williamson, Coase)
- Contractual design (standard provisions)
  - Monitoring and Incentives (see "Org. Design" Notes)
- Ownership of essential assets
- Reputations
- Bonding
- Others (situation specific)?

Transactions cost economics

Match the appropriate "governance structure" to characteristics of the transaction (Williamson)

Frequency	Asset Specificity: Non-Specific	Asset Specificity: Mixed	Asset Specificity: Highly Specific
Occasional	Markets	Neoclassical Contract	Neoclassical Contract
Recurrent	Markets	Relational Contract	Unified (Vertical Integration)

Incomplete Contracts Theory

Insights:

- **Contracts are incomplete**
- **There may be opportunities for mutual gain that can't be specified or enforced in a contract**

Story

- **Firm A and Firm B write a contract**
- **Firm A could make a specific investment that benefits firm B (more than cost), but isn't valuable to any other trading partner**
- **Knowing that once investment is made, Firm A has no way to recover cost, won't make the investment**

==>Incompleteness changes the nature of the relationship

Solutions: Allocate bargaining power

Use "hold-ups" to provide bargaining power

- Ownership of critical assets
- A role in trade

CSC/GD Case

- CSC pays up front for some fraction of expected future gains
- GD gives them bargaining power by transferring IT assets
- CSC now has improved incentives to make investments
  - Contract specifies that CSC gets to keep almost all of the gains from cost savings

Bottom Line on Outsourcing

- A substantial opportunity to improve economics of IS and other operations
- Be aware of contractual risks
- Manage the risks through careful contracting

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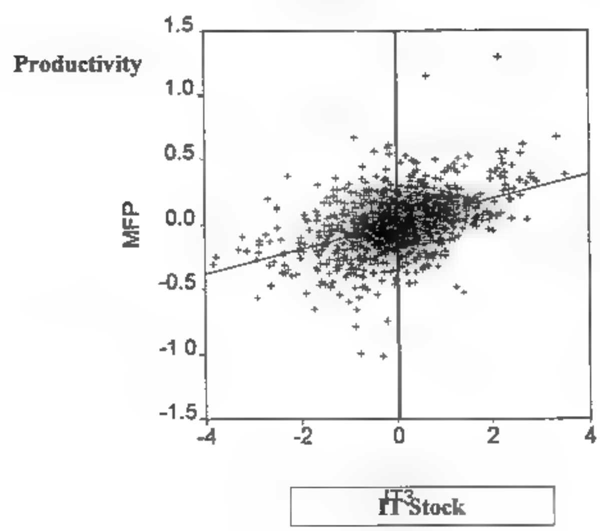
Evaluating IT Investments

OPIM 210

Il-Horn Hann

IT and Productivity



Evaluating IT Investments: NPV

- Net Present Value (NPV): Today's value of all future benefits less future costs of a project:

$$NPV = -I_0 + \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t}$$

where: *I_0 is the initial investment*
CF_t is the net "cash flow" in year t
T is the last period the investment has any value (+ or -)
r is the discount rate

- Procedure
  - *Determine appropriate risk-adjusted rate of return (r)*
  - *Calculate value created and cost accrued each year (CF)*
  - *Use the formula*

Other NPV Related Measures

- Payback Period
  - Sometimes used for large, one-time investments:

$$\text{Compute N that solves: } \sum_{t=0}^{N} CF_t - I_0 > 0$$

- Investment Index
  - Used for crude selection among multiple projects when there are investment limits

$$Investment\ Index = \frac{NPV}{Initial\ Investment}$$

- Internal rate of return (R): the discount rate that makes NPV = 0

IT costs
- Software
- Hardware
- Marketing
- Training
- software maintenance
- implementation
- facility costs

operational costs
v. implementation costs

Benefits

Tangibles -
Productivity
Reduce inventory
improve quality
smaller workforce
Less Floorspace.
cost saving,
cost Avoidance

Intangible
Flexibility
learning/experience
better decision making
more information
Employee Goodwill

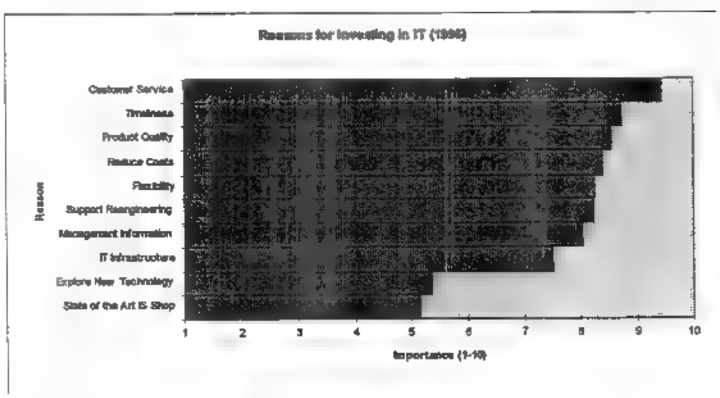
IT investments
what is appropriate
hall of margins,
market share and profit
Intangible tangible
benefits.
- Status Quo

Limitations of NPV

- Need to measure all costs and benefits now and in the future
  - Both how much and when
  - Which are easy to estimate and which are hard?
  - Why is IT unusually difficult to evaluate?

OPIM 210 - Evaluating IT Investments - Lecture 16 5

Why do managers invest in IT?

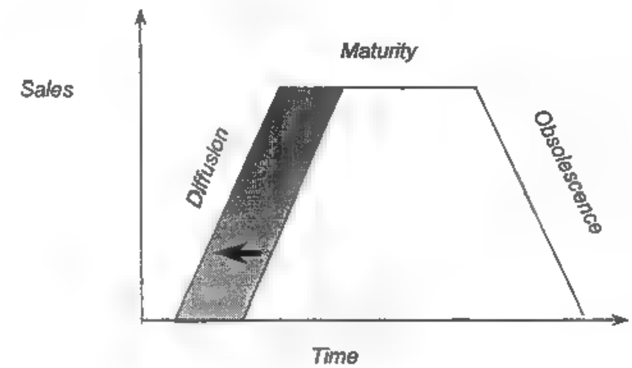


Source: *Brynjolfsson and Hitt, "The Customer Counts", InformationWeek, 1996*

OPIM 210 - Evaluating IT Investments - Lecture 16 6

Example of Intangible Value: Timeliness

Product Lifecycle and Time to Market



McKinsey: A 6 Month Delay on product with a 5 year life reduces total profits by 33%

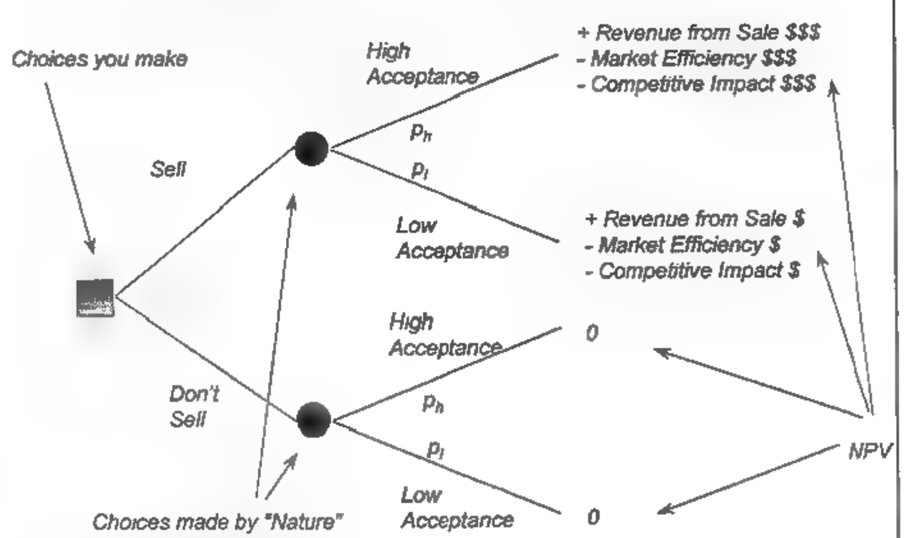
Making decisions when not all costs and benefits are quantifiable

- A two step approach - reverse NPV (Kaplan)
  - Use the hard numbers to calculate an NPV
  - Determine the amount of incremental value that is needed to make the investment breakeven (NPV gap)
  - Decide: Is there enough intangible value to fill the gap?
- A common and poor alternative
  - Assume that all unmeasured costs and benefits are zero

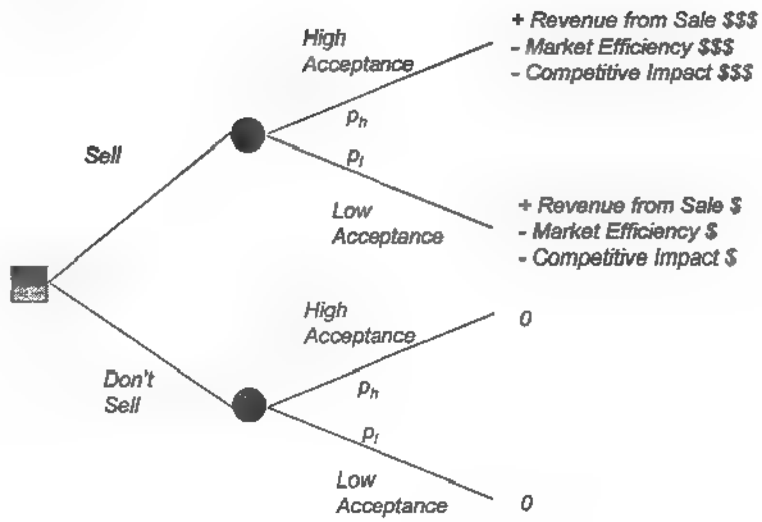
Decision Analysis

- Problem Example: Merrill Lynch-Bloomberg
  - Merrill owns a 30% of Bloomberg with veto power over sale of system to outside firms
    - » Bond trading support system
    - » Real time price feeds provided by Merrill
    - » Analytics and system provided by Bloomberg
  - Michael Bloomberg wants to make Bloomberg's analytics available to other firms (for a fee)
- Question: What should the board of Merrill do?

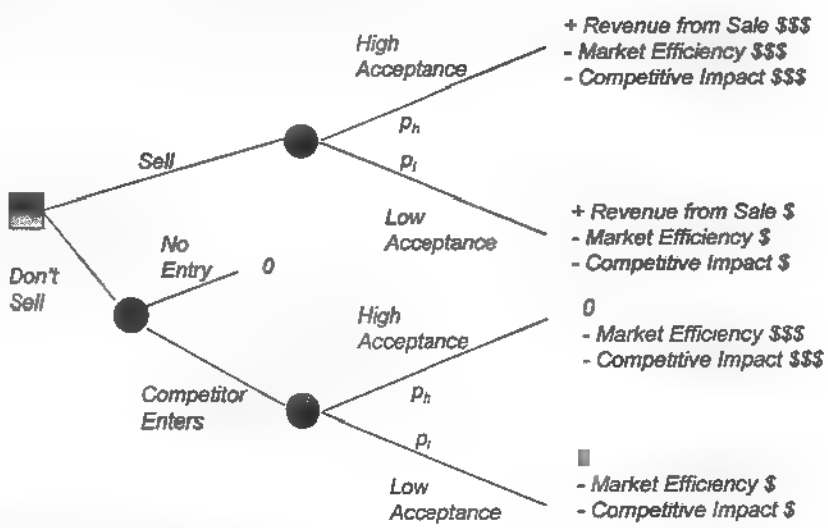
Decision Trees: Merrill-Bloomberg Sale



Analyzing Merrill-Bloomberg: Problem in their Terms



Correcting "Trap of the Vanishing Status Quo"



Real Options

- Idea
  - IT Investments have lead times
    - » Making an investment now may give you the **option** to make adaptations or other investments in the future not possible otherwise
  - Some types of investment decisions are irreversible
    - » Investing now eliminates or reduces the value of some types of future investments
- Analysis of IT tends to focus on the former and less of the latter

Risks of Strategic Systems...

- Identifying Risks (Clemons)
  - Functionality - doesn't do what you need
  - Project - can't get it done
  - Financial - too expensive or can't handle variability
  - Technical - can't be done
  - Systemic - world changes before project is done
- Dealing with risks
  - Work with specific risks
    - » Staged implementation at Bell Canada
  - Trade them off
    - » Functionality vs. Technical risk at First Boston

Bottom Line

- Work with the numbers first (NPV)
  - Quantify the easy ones; be creative to identify and quantify intangibles
  - Reverse DCF for the rest
- Structure the decision process (Decision trees)
  - Understand the base case
  - Recognize the value of flexibility
  - Recognize the value of information
- Identify and manage the risks

Mistakes not to make

- Make investments on faith
- Decide all IT investments are a strategic necessity and therefore don't need to be justified
- Ignore intangible benefits - these may be the most important

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Lecture 18 - Building Systems:
Intro to Systems Analysis

Il-Horn Hann

Agenda

- Systems development lifecycle
- Design methods & tools
- Management issues in design

Models of the development process

- Code and Fix (and later... "code like hell")
- Process oriented models
  - Waterfall
  - JAD
- Evolutionary models
  - Rapid prototyping
- Data-oriented models
  - Information Engineering (used for database designs)

Structured Design

- Study the current system
  - Interviews, Questionnaires, Observations
- Build a logical model
- Determine objectives for new system
- Build new logical model
- Analyze alternative designs

Other Evolutionary Methods

- Rapid Prototyping
  - Build a version of the system after a few initial discussions using...
    - » Paper (index cards, paper cutouts)
    - » A packaged prototyping tool
    - » A standard flexible tool like a 4GL
  - Development
    - » Iteratively refine prototype
    - » Use as specification for full system

Designers Toolbox

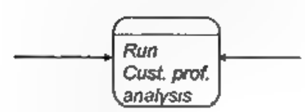
- E-R Diagrams
  - Define important data and relationship between them
  - Useful later for designing database structure
- Dataflow diagrams
  - Resembles a simplified flowchart
  - Useful for mapping and understanding processes
- Others
  - various Business System Planning (BSP) diagrams
  - OO design diagrams (e.g. inheritance structure)
  - Petri nets and other odd computer science tools

Data Flow Diagram: How?

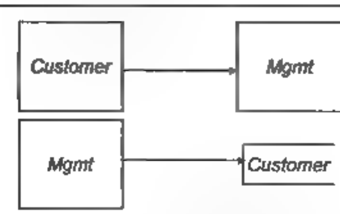
- Make a list of business activities: External entities, data flows, processes, data stores
- create context diagram: show external entities and data flows to and from the system
- Draw Diagram 0, the next level. Show general processes
- Create a child diagram for each of the processes in Diagram 0

Data Flow Diagram:Common Mistakes

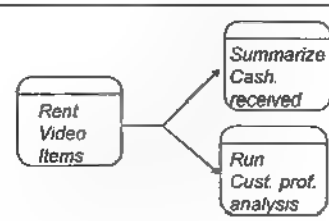
- The Black Hole



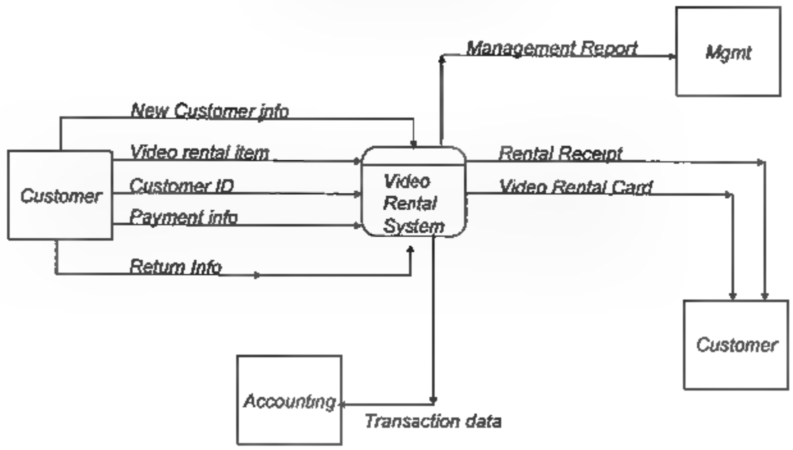
- Data flows not connected to a process



- Split data flows



Context Diagram



Characteristics of failed projects

- Bad design practices
  - Too much focus on method; not on product
  - Fail to involve users/get the wrong users (Bob is available...)
  - Not have a clear business objective at outset
- Bad project management practices
  - Developer optimism/over-aggressive scheduling
  - "Silver bullet syndrome"
  - Staffing problems: wrong size team/staff turnover
  - Skip steps (like analysis...)
  - Off-the-cuff project estimates
  - Many others
    - » Classic reference: Brooks, Mythical Man Month
    - » Modern reference: McConnell, Rapid Development

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OPIM 210
IT and Organizational Design

Il-Horn Hann

The Two Faces of Organizational Structure: Internal and External Organization

- Internal Organization
  - Ford accounts payable - redefine processes
  - Hallmark - coordinate design teams
  - IBM credit- consolidate responsibility
  - Phillips 66, Tiger Creek - changing information and incentives
  - Other buzzwords: information based organization, high performance work systems, reengineering
- External Organization
  - WalMart, Benetton - tight links to suppliers
  - CSC, Kodak, DVFS - outsourcing
  - Other buzzwords: network corporation, virtual corporation, value-added partnership

Economic views of internal organization

- "Organizational Architecture"
  - Allocation of decision rights
    - » General and specific knowledge
  - Measurement systems
  - Reward and punishment rules

  Incentives

- Limits on human information processing
- Human capital
  - Education versus specific skills

Organizational Architecture: Decision Rights

"We've got to decentralize to be flexible...
We've got to centralize for efficiency" (Scott Adams, *Dilbert*)

- Advantages of centralization

- Chain of command - Less confusion
- Efficiency - Economies of scale

- Advantages of decentralization

- motivation
- Responsiveness to Market
- Flexibility

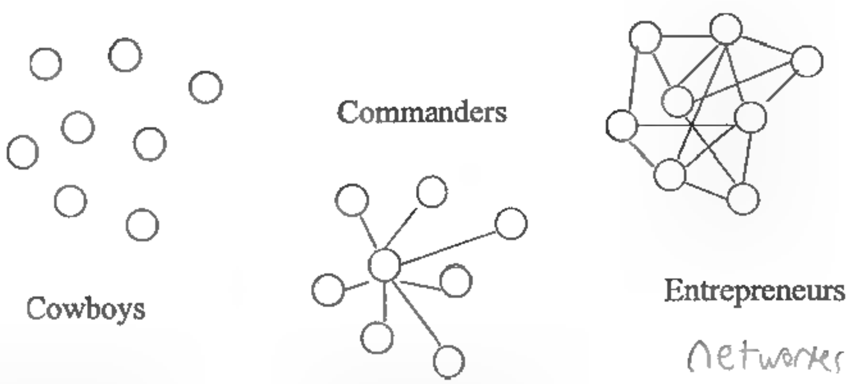
- Role of Information Technology

Decision Rights: The economic view

"Collocate decision rights with necessary information"
(Jensen and Meckling)

- Two types of knowledge (Hayek)
  - General: easily communicated
  - Specific: difficult to communication or transfer
    - » Have to be there
    - » Don't know what you know (tacit)
- Centralized vs. decentralized
  - Where does specific knowlege reside?
  - How easily can you exploit general knowledge?
    - » Obtaining general knowledge
    - » Communicating general knowledge

Another model: Communications costs



networks

independent
cost High

dependent
Hierarchial
Costs Lower

costs much lower

Organizational Architecture: Incentives

- Problem is to maximize value subject to:
  - Incentive compatibility: workers want to do what they are supposed to do rather than something else
  - Individual rationality: no one wants to quit
- Tradeoffs between incentives and risk
  - If effort could be observed exactly, there are no problems
    - » Because effort often can't be seen, pay based on output
  - Output-based incentives
    - » Workers perform better when paid based on output but...
    - » Because output is not perfectly measured or determined by effort this places risk on workers
    - » Trick is to balance increased productivity with "cost" of risk

Organizational Architecture: Incentives

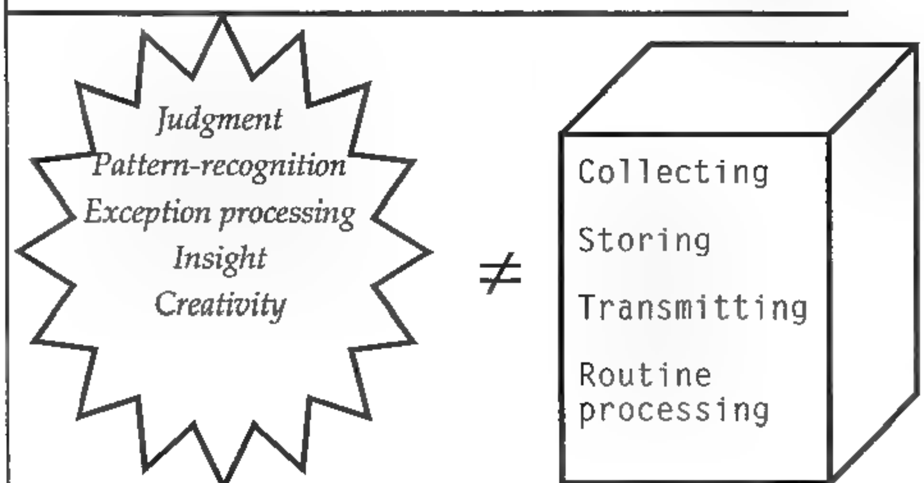
- A good incentive system...
  - Focuses on the bottom line: Includes only factors that relate to productivity (output, effort)
  - is Accurate: Minimizes risk by using good indicators of the organizational goals
  - is Complete: Does not exclude key objectives
    - » What happens if something is missing?
    - » How can this be fixed?
  - is Understandable
  - resists Gaming
- Role of IT
  - Monitoring
  - Changes nature of work

Limits on human information processing: Bounded Rationality

"The scarce resource is not information, it is the processing capacity to attend to information" (Herbert Simon)

- Human limits
  - Cognitive limits: 7 +/- 2 things in short term memory (Miller, 1956)
  - Can't know everything (price of IBM tomorrow?)
  - Even if you did, may not help (information overload)
- Information technology and human information processing
  - Communications, databases...
  - Massive computational power: parallel processors, supercomputers
  - Expert systems/AI

Human versus Machine Decision Makers



Human Capital: Education and Skills

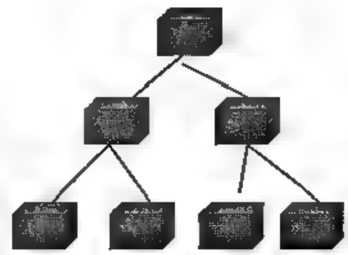
- Two types of skills
  - General skills
    - » "High level" scientific knowledge (reasoning, problem solving)
    - » Applicable in a wide variety of environments
    - » Often accumulated through education
  - Specific skills
    - » Knowledge of how to solve particular problems (e.g. how do I run this lathe? What form do I fill out for an address change?)
    - » Tend to applicable in more narrow domains
    - » Often accumulated through experience
- Role of technology
  - Enhances some types of skills
  - Replaces some types of skills
  - Shift the type of skills required from specific to general

Organizational Design: Coordination of design variables

- Complementarities (Milgrom and Roberts)
  - Design variables are complementary if higher levels of one design variable increases the marginal value of another design variable
- Implications
  - Can't mix and match: Only certain combinations of organizational characteristics are likely to appear (in successful organizations)
  - Can't just change one dimension
    - » Attempting to change one dimension may make firm worse off than if they stayed with the "system"
    - » Justification for reengineering (radical, coordinated change)

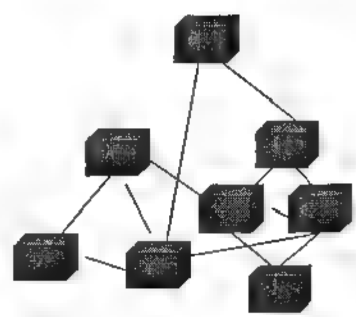
Hierarchies

Design Variable	Traditional Hierarchy
Decision Rights	
· Decision Making	Centralized "Command and Control"
· Job Design	Narrow "Positions" Procedures
Monitoring	Supervision Input oriented
Reward Systems	Tenure Promotion
Knowledge	
General knowledge	Centralized
· Specific knowledge	Unused
Human capital	Specific



Information Based Organization (Drucker)

Design Variable	Information-based Organization
Decision Rights	
Decision Making	Decentralized "Empowerment"
· Job Design	Broad/multiskill Job rotation Teams
Monitoring	Team-based Outcome
Reward Systems	? Variable pay?
Knowledge	
· General knowledge	Everywhere
· Specific knowledge	Local
Human capital	General (education)



Comparison

Design Variable	Information-based Organization	Traditional Hierarchy
Decision Rights		
· Decision Making	Decentralized "Empowerment"	Centralized "Command and Control"
· Job Design	Broad/multiskill Job rotation Teams	Narrow "Positions" Procedures
Monitoring	Team-based Outcome	Supervision Input oriented
Reward Systems	? Variable pay?	Tenure Promotion
Knowledge		
· General knowledge	Everywhere	Centralized
· Specific knowledge	Local	Unused
Human capital	General (education)	Specific

Economic view of external organization

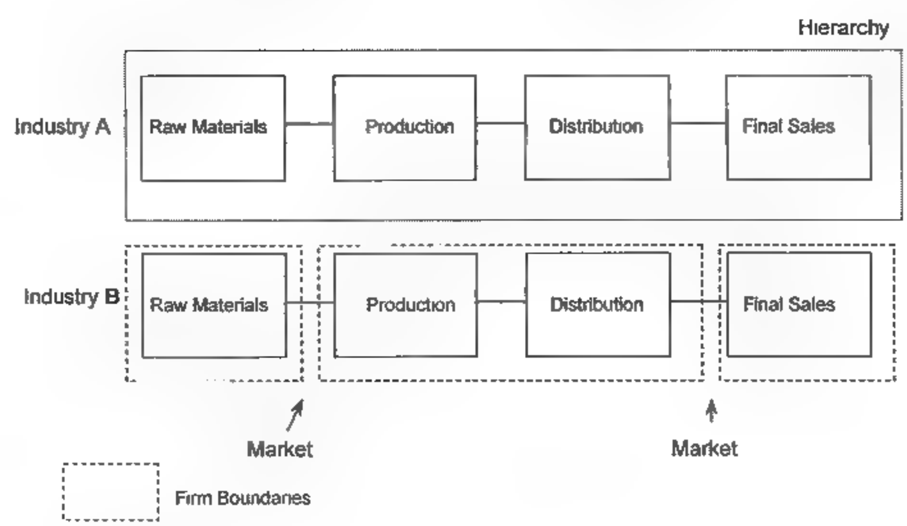
- External organization decision trades off three types of costs
  - Transactions costs (Coase; Williamson)
    - » Frictional costs: writing contracts, finding suppliers, specification
    - » Implicit costs (transaction risks): cost of contractual problems that arise because of imperfect information and incentive misalignment
      - poaching - use of a resource in an unintended way that hurts the entity that provided it
      - shirking - deliberate underperformance on a task that is hard to measure
      - opportunistic renegotiation - when two parties are not equally committed to a relationship, the party with more bargaining power renegotiates the contract for more surplus
  - Production costs
    - » Scale economies; economies of specialization, economies of scope...
  - Agency costs: cost of internal incentive misalignment

Relabeling: Coordination costs

- Tradeoffs between three types of costs
  - Production costs (as before)
  - External coordination costs = transaction risks + contracting frictions
  - Internal coordination costs= agency costs + communications (internal frictions)
- General Idea: Choose "make" vs. "buy" to minimize total costs

	Make	Buy
Production	High	Low
Internal Coordination	High	Low
External Coordination	Low	High

Example: Markets and Hierarchies



Coordination Costs and Information Technology

- External coordination

- Internal coordination

Prediction

- Information technology lowers the cost of coordination
  - Internal coordination needs are roughly the same for markets and hierarchies
  - Markets are more coordination intensive in terms of external coordination

↓

IT leads to a shift from hierarchies to markets

Alternative prediction: "Move to the Middle"

- Move away from hierarchies to coordination intensive hybrids
- Why?
  - In order to lower transactions costs, need to have close coordination which cannot be done in arms length markets (Clemons)
  - Market incentives can be too powerful
    - » Cannot get suppliers to invest in the relationship
- Examples:
  - Preferred suppliers: Japanese auto manufacturers
  - Partnerships: IBM and USAA for image technology
  - Outsourcing: DVFS, CSC/GD

Empirical Evidence

- IT and Organizational Architecture
  - IT associated with decentralized authority, greater human capital and subjective/team-based incentives (Hitt, 1996; Brynjolfsson and Hitt, 1995; 1996)
- IT and wage inequality
  - Evidence that IT may be associated with increases in wages of skilled labor, but decreases in unskilled labor (B&H; Capelli; Hunter; Berman, Bound & Griliches)
- IT and firm structure
  - IT associated with decreasing firm size (Brynjolfsson et. al, 1994)
  - IT associated with small, less vertically integrated firms, but (possibly) greater diversification (Hitt, 1997)

Summary: Organizational Economics in ~80 minutes

- Key concepts
  - Organizational architecture: decision rights, incentives
  - Bounded rationality and information overload
  - Complementarities: why there are work systems
  - Transaction cost economics
  - Coordination costs: markets, hierarchies or "move to the middle"
- Think carefully about how IT plays into these factors
  - Will reappear in Phillips 66, Tiger Creek, CSC/GD, DVFS and other cases

Problem Set #2 - Technology
Grading Key - Il-Horn Hann

Here are the sample answers to the problem set. I am providing this to you because I want to make sure you are comfortable with the technology answers before the midterm. These are not the only correct answers to these questions (particularly the JAVA questions), just a suggested solution that you can use as a reference.

1. (40%) Recently companies have been incorporating 128-bit video cards into desktop PCs for high performance multimedia applications. These cards contain a microprocessor which handles the operation of the card, memory for storing screen images and a digital to analog converter for converting data stored in memory into a video signal for a monitor. They are designed to be installed in PC-compatible computers using a Pentium processor and operate over the PCI bus. Please answer the following questions.

a. What does "128-bit" mean in this context? What does "performance" mean in this context?

128 bits refers to the word size for the processor. Also acceptable is data bus width. Performance refers to the speed at which the card can update make changes to the screen based on changes in instructions or data.

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5) Uniquely positioned? There are other possibilities like disallowing active code from the web or limiting access to trusted sites, but JAVA seems to solve this problem quite nicely. Maybe not uniquely positioned, but clearly a contender a preferred solution among very few choices.

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Doubling the size of the internal instruction and data caches from 16K to 32K
Adding more length to the pipeline (so that more instructions can be prefetched)
Improving write speed

Better branch prediction (better at guessing which code is next)

In addition, the MMX includes 57 new instructions that provide parallel-processing capabilities that are particularly suited to multimedia data. Basically, a set of instructions are added that allow 64 bit words to be manipulated as collections of 8 byte elements. For example, one instruction allows you to add two sets of 8 single-byte integers:

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4/4

Business Reengineering

Il-Horn Hann

1

Introduction

- Why do we need reengineering?

Limitations of old thinking
(cont'd on back)

- What is the essence of reengineering?

Reevaluating the whole thing

2

Reengineering: Examples

- Ford:
  - merge invoice process with goods delivery
- Hallmark
  - concentrate on the whole, not parts
- Taco Bell
  - focus on customer, rather than operations

3

Champy: The Principles

- Focus on business processes not departments, tasks, people, etc.
- Consolidate processes; shift responsibilities to single people/teams
- Combine physical and information work
- Ignore geography
- Do things in parallel with early coordination rather than late coordination

Davenport & Short:
5 Steps in Process Redesign

- Develop business vision and process objectives
  - Operationalization of visions
- Identify processes to be redesigned
  - What's a process
  - Which one should be redesigned
- Understand and measure existing processes
  - Measurement issues

5

Davenport & Short:
5 Steps in Process Redesign

- Identify IT levers
  - Bottlenecks
  - Consolidation
- Design and prototype system and new process
  - Tricks for redesign
  - Tricks for implementation

6

Complementarities

- Some type of things naturally work together while others don't
  - The marginal value of one activity is raised when another activity is done
- Ex.: Modern manufacturing vs. mass production
  - MM: flexible technology, educated staff, short production runs, custom products
  - MP: rigid technology, low skill staff, long production runs, standardized products

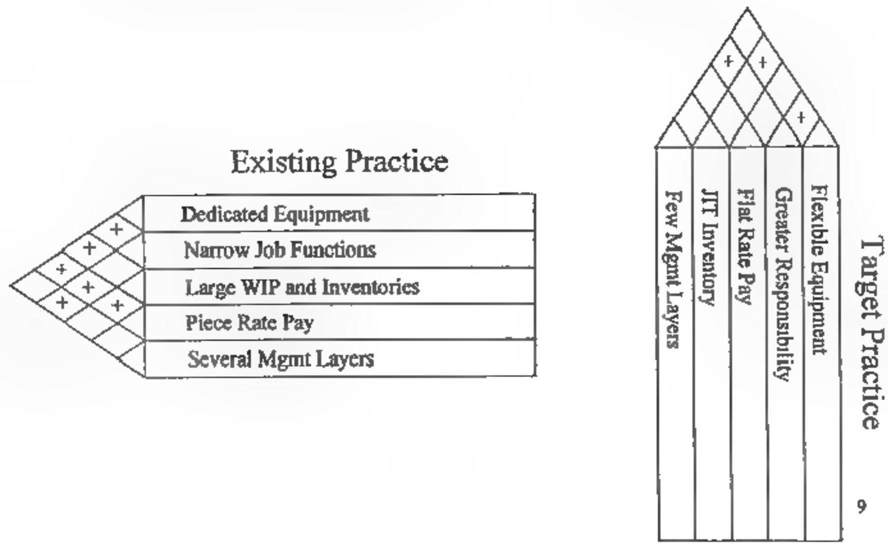
7

The Matrix of Change

- Example: MacroMed
  - producer of medical products
    - Betaplex, a sterile adhesive compound
  - market share fell 9% from1989-1991
    - competition: private labels, new entrants
  - cost pressure: 18% price hike
  - need for greater flexibility and modern manufacturing
  - change involves: work organization, market strategy, supplier relations, etc.

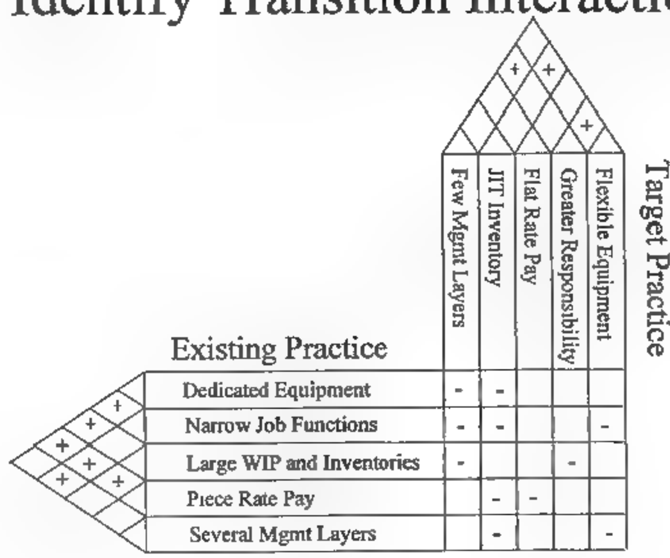
8

Identify System Interactions



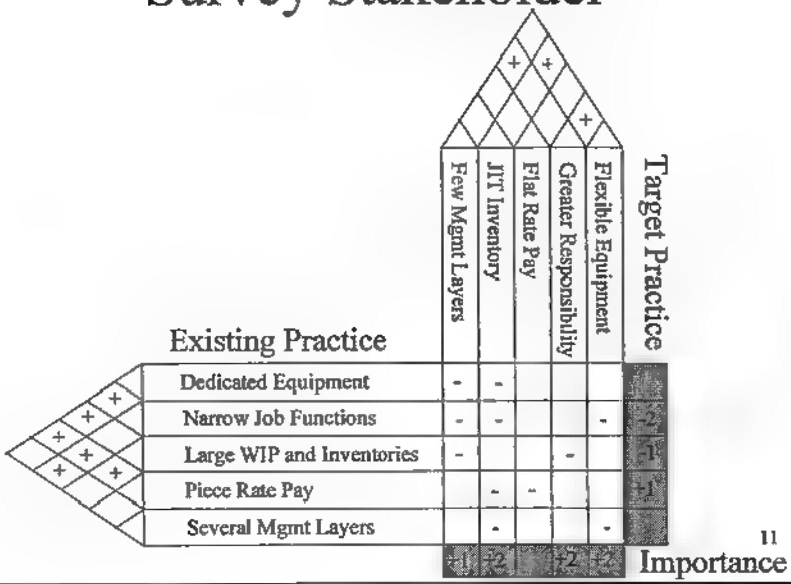
9

Identify Transition Interactions



10

Survey Stakeholder

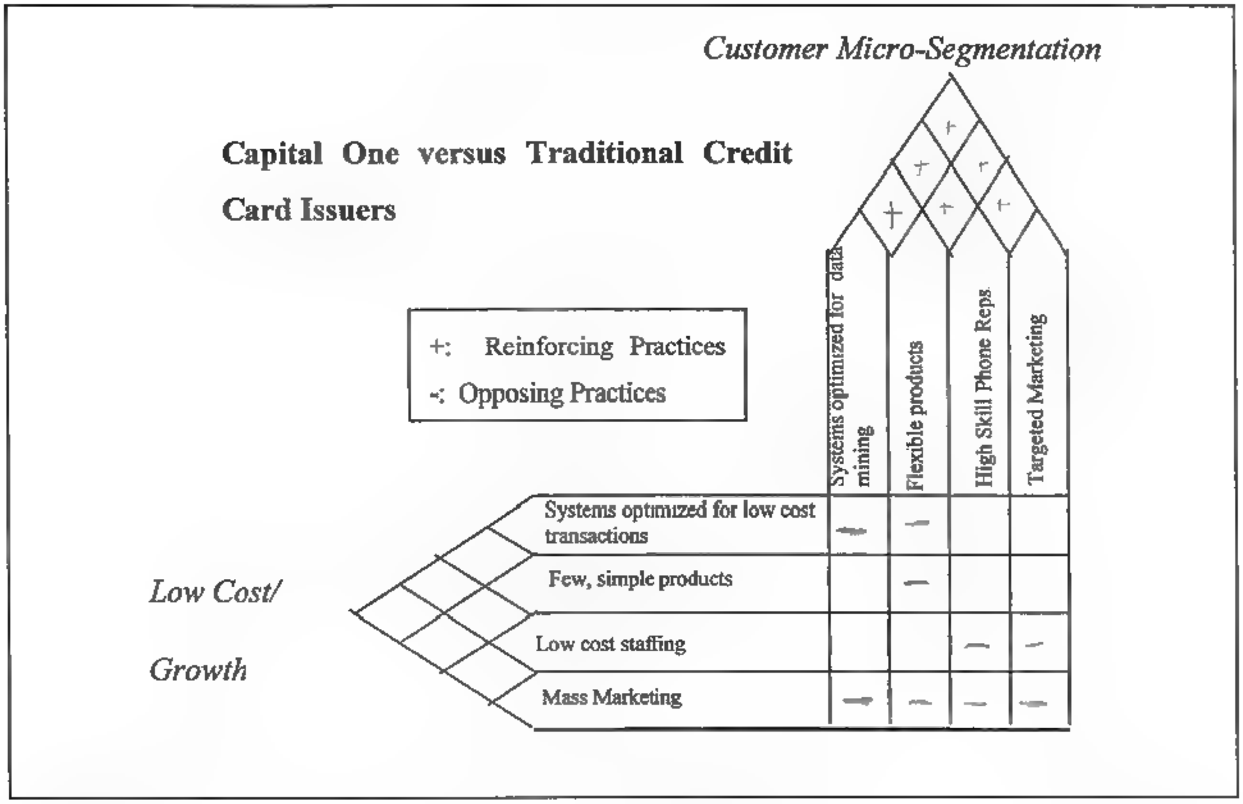


11

Management Issues

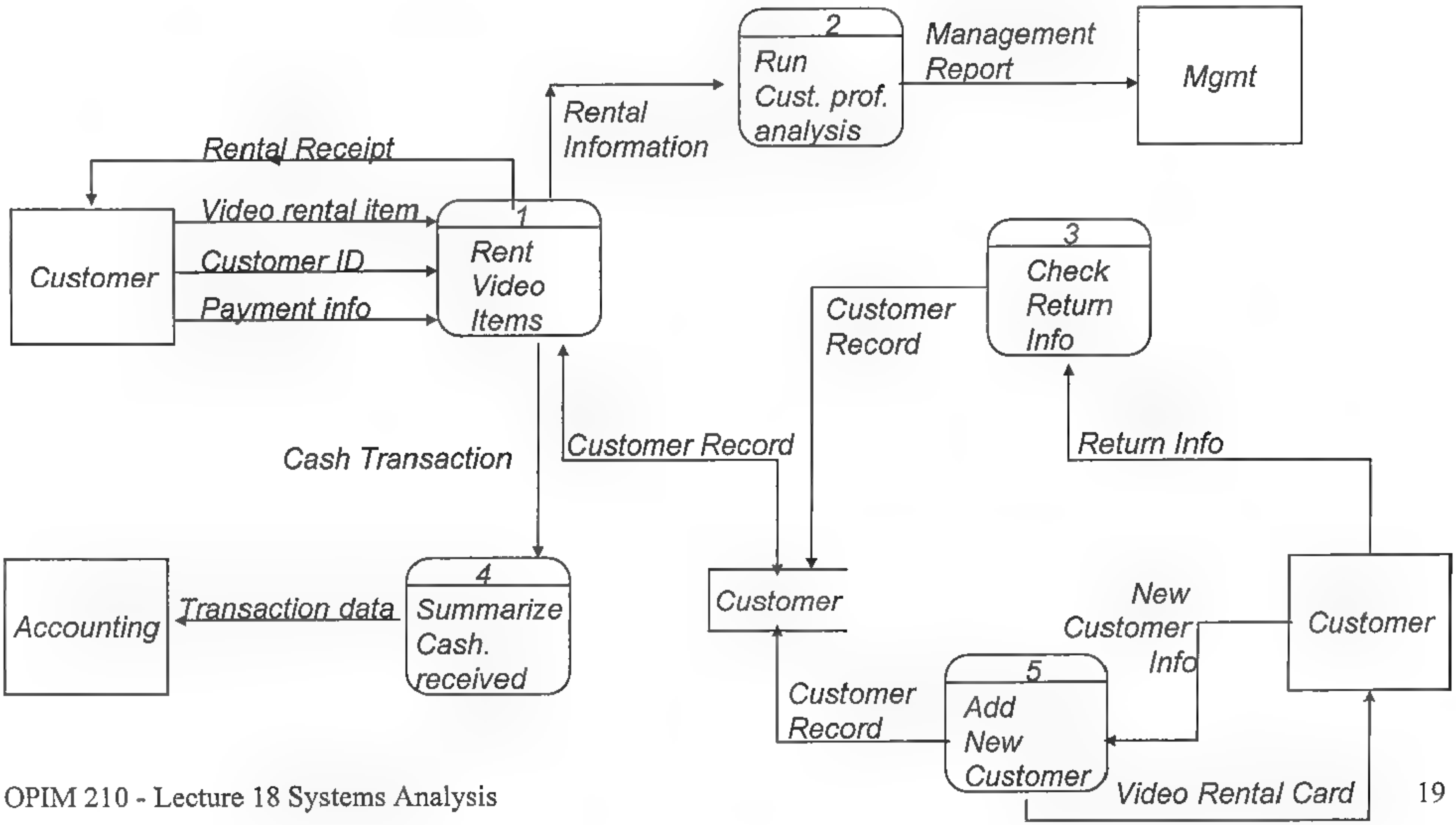
- Critical for success
  - Executive leadership
  - Low level participation
  - Commitment to radical change
- Reality
  - High failure rate
  - Reasons

12



Capital One's "Test and Learn" Strategy vs. Traditional Issuers

Diagram 0



Customer
Video rental item
Customer ID
Payment info
Rental Receipt
1
Rent
Video
Items
Rental
Information
2
Run
Cust. prof.
analysis
Management
Report
Mgmt
Cash Transaction
4
Summarize
Cash.
received
Transaction data
Accounting
Customer Record
Customer
Customer
Record
3
Check
Return
Info
Return Info
Customer
New
Customer
Info
5
Add
New
Customer
Customer
Record
Video Rental Card

Problem Set #2 - Technology
Grading Key - Il-Horn Hann

Here are the sample answers to the problem set. I am providing this to you because I want to make sure you are comfortable with the technology answers before the midterm. These are not the only correct answers to these questions (particularly the JAVA questions), just a suggested solution that you can use as a reference.

1. (40%) Recently companies have been incorporating 128-bit video cards into desktop PCs for high performance multimedia applications. These cards contain a microprocessor which handles the operation of the card, memory for storing screen images and a digital to analog converter for converting data stored in memory into a video signal for a monitor. They are designed to be installed in PC-compatible computers using a Pentium processor and operate over the PCI bus. Please answer the following questions.

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